SE LABS

INSTRUCTION MANUAL

MODEL 3800

DIGITAL MULTIMETER

RACAL-DANA

Publication

980419

MODEL 3800

DIGITAL MULTIMETER

RACAL-DANA

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WARRANTY

Within one year of purchase, Racal-Dana will repair or replace your instrument, at our option, if in any way it is defective in material or workmanship. The instrument must be returned to the country of purchase, unless prior arrangement has been made, and Racal-Dana Instruments will pay all parts and labor charges. Just call Racal-Dana Product Service at (714) 859-8999 in U.S.A., Windsor (07535) 69811 in England, (3) 955-8888 in France, 06102-2861/2 in Germany or (02) 6459558/6468189 in Italy for assistance. We will advise you of the proper shipping address for your prepaid shipment. Your instrument will be returned to you freight prepaid.

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FOR YOUR SAFETY

Before undertaking any maintenance procedure, whether it be a specific troubleshooting or maintenance procedure described herein or an exploratory procedure aimed at determining whether there has been a malfunction, read the applicable section of this manual and note carefully the WARNING and CAUTION notices contained therein.

The equipment described in this manual contains voltage hazardous to human life and safety and which is capable of inflicting personal injury. The cautionary and warning notes are included in this manual to alert operator and maintenance personnel to the electrical hazards and thus prevent personal injury and damage to equipment.

If this instrument is to be powered from the AC line (mains) through an autotransformer (such as a Variac or equivalent) ensure that the common connector is connected to the neutral (earthed pole) of the power supply.

Before operating the unit ensure that the protective conductor (green wire) is connected to the ground (earth) protective conductor of the power outlet. Do not defeat the protective feature of the third protective conductor in the power cord by using a two conductor extension cord or a three-prong/two-prong adaptor.

Maintenance and calibration procedures contained in this manual sometimes call for operation of the unit with power applied and protective covers removed. Read the procedures carefully and heed Warnings to avoid "live" circuit points to ensure your personal safety.

Before operating this instrument:

1. Ensure that the instrument is configured to operate on the voltage available at the power source. See Installation Section.

2. Ensure that the proper fuse is in place in the instrument for the power source on which the instrument is to be operated.

3. Ensure that all other devices connected to or in proximity to this instrument are properly grounded or connected to the protective third-wire earth ground.

If at any time the instrument:

- Fails to operate satisfactorily
- Shows visible damage
- Has been stored under unfavorable conditions
- Has sustained stress

It should not be used until its performance has been checked by qualified personnel.

FOR YOUR SAFETY

DANA.

MANUAL CHANGES

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Date of Change July, 1970

On Page 2-1 add the following sentence to Section 2.6

Instruments designated by a "Dash 1" (-1) following the model number are equipped with a duplicate set of input binding posts on the rear panel of the instrument.

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SECTION 1

GENERAL DESCRIPTION

1.1 GENERAL

The Dana Series 3800 Digital Multimeter (figure 1.1) is a low-cost, accurate, 3 digit instrument, measuring AC on four ranges, DC on five ranges and ohms and DC current on six ranges. The readings are displayed on a 3 digit readout with a fourth digit providing 20% overrange.

Options include:

Electrical output (op-1) for providing non-isolated binary 1-2-4-8 coded decimal (BCD) data for driving a printer or other digital recorder;

Rack mounting flanges (DPN 403350) for converting the DMM from a bench top to rack mounted instrument;

Export transformer (3800-E) which allows modification for use on power lines of 100, 120, 200, 220 or 240 volts AC, 50 Hz to 70 Hz.

1.2 MECHANICAL DESCRIPTION

The basic DMM is designed as a bench top instrument and comes equipped with a bail handle for easy carrying and display viewing. All components of the basic instrument including the power supply are mounted on a single printed circuit board and housed in the high-impact plastic case. Access to the interior of the instrument for calibration and

Figure 1.1 - Model 3800 DMM

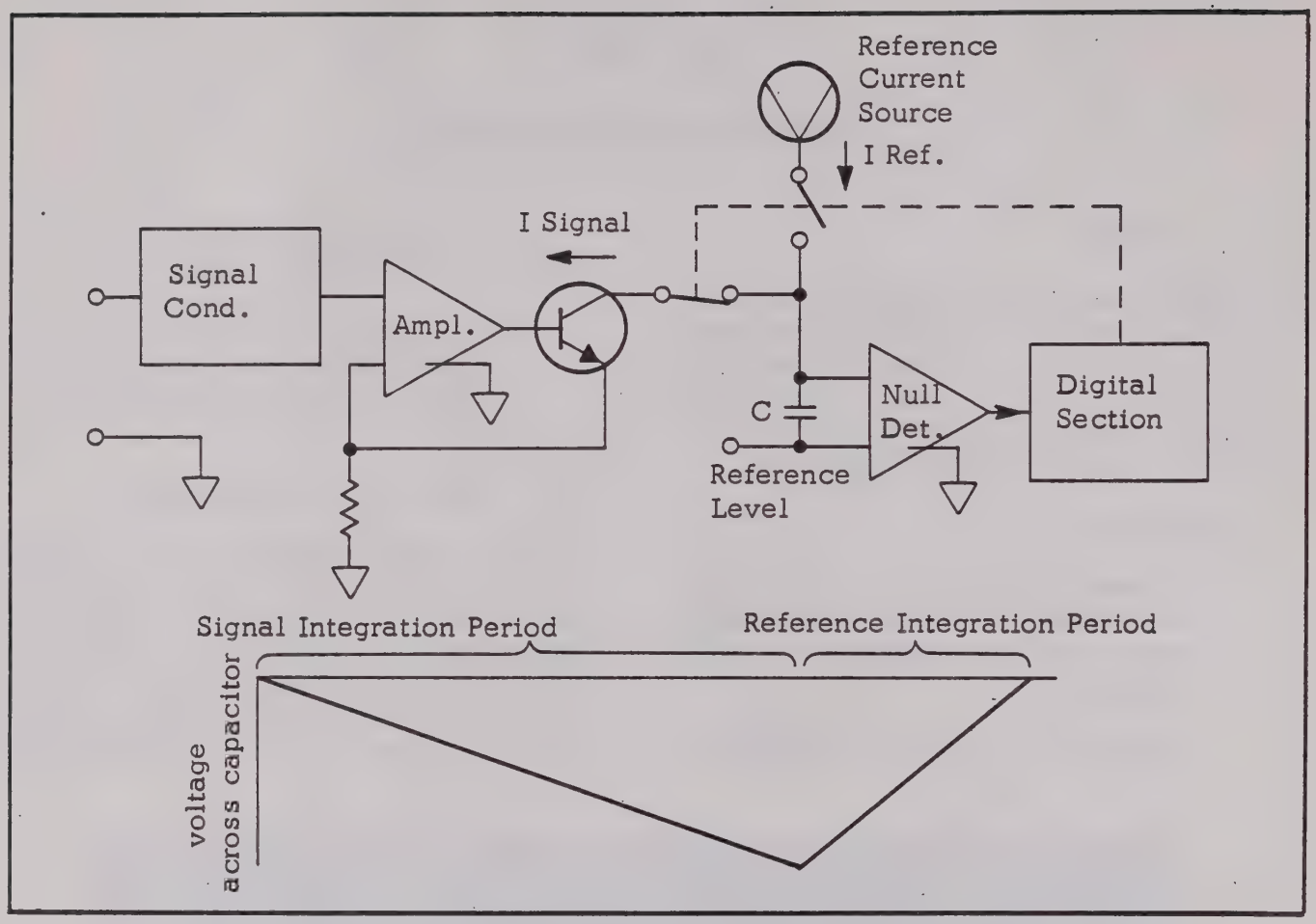


Figure 1.2 - Simplified Block Diagram

maintenance is made by removing five screws on the rear panel.

1.3 ELECTRICAL DESCRIPTION

The Series 3800 DMM, shown simplified in figure 1.2, utilizes the dual-slope integration method of Analog to Digital Conversion. The signal being measured is converted by the signal conditioning circuitry into a 1 volt full scale (less overrange) level. The scaled DC level is converted into a proportional, negative current and applied to a capacitor (c) for a set time period. At the end of this signal integration period, a voltage has accumulated across the capacitor which is proportional to the input voltage. The signal current is removed from the capacitor and replaced by a stable positive reference current, causing the capacitor to discharge by the reference current at a fixed rate. The time required to discharge the capacitor is measured and displayed by the digital portion of the DMM.

1.4 SPECIFICATIONS

Specifications are shown in table 1.1.

TABLE 1.1 - DANA SERIES 3800 SPECIFICATIONS

DC VOLTAGE		
Full Scale Ranges:	± 119.9 mV, ± 1.199, ± 11.99, ± 119.9, and 1199 V	
Resolution:	100 μV	
Polarity:	Automatic bi-polar	
Accuracy:	90 days, 15° to 35°C ± 0.1% of reading ± 1 digit	
Stability:	6 months ± 0.1% of reading	
Input Resistance:	1 V range 1000 megohms minimum 100 mV range 100 megohms minimum 10, 100, and 1000 V ranges 10 megohms	
Normal Mode Noise Rejection:	At or near 60 Hz	60 dB (1000 to 1)
Common Mode Noise Rejection:	At or near 60 Hz (1000 ohms, either lead)	100 dB (100,000 to 1)
Response Time:	1 second	
AC VOLTAGE		
Full Scale Ranges:	1.199, 11.99, 119.9, and 1199 V RMS	
Resolution:	1 mV RMS	
Accuracy:	90 days, 15° to 35°C 40 Hz to 1 kHz ± 0.3% of reading ± 1 digit 1 kHz to 10 kHz ± 0.4% of reading ± 1 digit 10 kHz to 100 kHz ± 0.9% of reading ± 1 digit	
Input Resistance:	2 megohms on 1 V range 1 megohm on all other ranges	
Shunt Capacitance:	100 pF	
Common Mode Noise Rejection:	At or near 60 Hz (1000 ohms, either lead)	60 dB (1000 to 1)
Response time	2 seconds	
Maximum Voltage Rating (Any Range):	500 volts RMS to 10 kHz, decreasing to 150 volts at 100 kHz	
RESISTANCE		
Full Scale Ranges:	119.9 ohms, 1.199, 11.99, 119.9, 1199 kilohms and 11.99 megohms	
Resolution:	100 milliohms	
Accuracy:	90 days, 15° to 35°C 1, 10, 100 kilohm ranges ± 0.2% of reading ± 1 digit	

Table 1.1 Specifications Continued

ACCURACY: (Continued)	100 ohms, 1 megohm ranges ±0.4% of reading ± 1 digit 10 megohm range ± 1.0% of reading ± 1 digit	
Response Time:	0.1, 1, 10, and 100 kilohm ranges 1 second 1 megohm range 2 seconds 10 megohm range 12 seconds	
Current Through Unknowns:	0.1 kilohm range 1 kilohm range 10 kilohm range 100 kilohm range 1 megohm range 10 megohm range	10 milliamperes 1 milliamperes 100 microamperes 10 microamperes 1 microampere 0.1 microampere
Fault Voltage:	0.1, 1, 10 megohm ranges 1, 10 kilohm range 0.1 kilohm range	500 volts peak 125 volts peak 70 volts peak

DC CURRENT

Full Scale Ranges:	11.99 and 119.9 μA, 1.199, 11.99, 119.9 and 1199 mA	
Resolution:	10 nA	
Accuracy:	90 days, 15° to 35°C 10 and 100 μA, 1, 10, 100 mA ranges ± 0.2% of reading ± 1 digit 1000 mA range ± 0.4% of reading ± 1 digit	
Shunt Values:	10, 100 μA 1, 10 mA 100, 1000 mA	10 kilohms ± 0.1% 100 ohms ± 0.1% 1 ohm ± 0.3%
Voltage Drop:	1000 mA, 10 mA, 100 μA ranges 1.2 volts 100 mA, 1 mA, 10 μA ranges 0.12 volts	
Fault Current:	100, 1000 mA ranges 1, 10 mA ranges 10, 100 μA ranges	2.2 amps 70 mA 7 mA

GENERAL

Digitizing Time:	8 ms
Maximum Common Mode Voltage:	250 V peak ac or dc
Maximum Power Requirement:	10 watts
Operating Temperature:	10° to 40°C
Warmup:	10 minutes to full accuracy
Dimensions:	3-½ x 8-½ x 11-¼ inches
Weight:	10 pounds (approx.) net, 13 pounds (approx.) shipping
Guarantee:	12 months, faulty workmanship or component failure.

SECTION 2

INSTALLATION AND OPERATION

2.1 UNPACKING AND INSPECTION

2.2 The Model 3800 DMM is secured by four, molded, plastic-foam forms and packaged in a double-walled cardboard carton for shipment. The plastic forms hold the DMM securely in the carton and absorb any reasonable external shock normally encountered in transit. Prior to unpacking, examine the exterior of the shipping carton for any signs of damage. Carefully remove the DMM from the carton and inspect the exterior of the instrument for any signs of damage. If damage is found, notify the carrier immediately.

2.3 POWER CONNECTIONS

2.4 A standard eight-foot, three-wire, power cable is permanently attached to the instrument.

2.5 INPUT/OUTPUT CONNECTIONS

2.6 Signal input binding posts are located on the front panel of the instrument. Connections to these terminals is made with a standard "banana" plug. Connections are made as described under "OPERATION", paragraph 2.17. A 36-pin connector is located on the back panel of instruments equipped with the Option 1 digital output. A hooded mating connector is supplied with instruments having this option.

2.7 CONTROLS

2.8 The location of the front panel controls is shown in figure 2.1. The following paragraphs describe the operation of each control.

Figure 2.1 - Model 3800 Controls

2.9 POWER SWITCH

2.10 The power switch is a two-position slide switch. The OFF position removes all power to the instrument. Selecting the ON position activates the instrument, taking 5 measurements a second.

2.11 OFFSET

2.12 This is a FLAT-BLADE screwdriver adjustment used to adjust out thermal offsets. The adjustment also provides a means of adjusting out unwanted signals at the measurement source. Instructions for this control are covered in paragraph 2.22.

2.13 RANGE CONTROL

2.14 The range control is a six-position switch which selects ranges from 0.1 to 10,000. Inscriptions on the panel and in table 2.1 define which ranges can be used for particular functions.

2.15 FUNCTION CONTROL

2.16 The Function Control is a five position switch that selects the type of measurement required. The positions are;

VDC - Selected for DC Voltage measurements, with full scale ranges of 0.1 to 1000 volts.
VAC - Selected for AC Voltage measurements, with full scale ranges of 1 to 500 volts max.
MADC - Selected for DC current measurements, with full scale ranges of 1 to 1200 milliamps.
μADC - Selected for DC current measurements, with full scale ranges of 10 and 120 microamps.
Ohms - Selected for Resistance measurements, with full scale ranges of 0.1 to 12 Megohms

2.17 OPERATION

2.18 General. The instrument is designed for the simplest possible level of operation. Once the instrument has been connected to the power line and to the signal source in accordance with the instructions, the operation can make all the required measurements by setting the front panel controls to the indicated positions.

2.19 INPUT CONNECTIONS

2.20 Inputs to the DMM are made through three terminals located on the front panel as shown in figure 2.1. These consist of a red VOLTS terminal for DC and AC voltage measurements, and white OHM/AMPS terminal for DC current and resistance measurements. When AC or DC volts are selected by the function switch the OHM/AMPS terminal is open and when the function switch is in the current or ohms position the VOLTS terminal is open. This gives a margin of safety against inadvertantly supplying the wrong input for a given function, provided the input is connected to the proper terminals. Shown in figure 2.2 are the various configurations for connecting input to the DMM. DC voltage and current inputs may be of either polarity.

2.21 FRONT PANEL ZERO

2.22 Set the function switch to VDC and the range switch to 100 mVDC. Connect a jumper across the VOLTS (Red) and COMMON (Black) terminals. Adjust the OFFSET potentiometer for a display of 000 with the + and — polarity

Table 2.1 - Available Ranges

DC	100 mV	1	10	100	1000	
AC	—	1	10	100	1000	—
MA	—	1	10	100	1000	—
μA	—	—	10	100	—	—
OHMS	100	1K	10K	100K	1000K	10 Meg

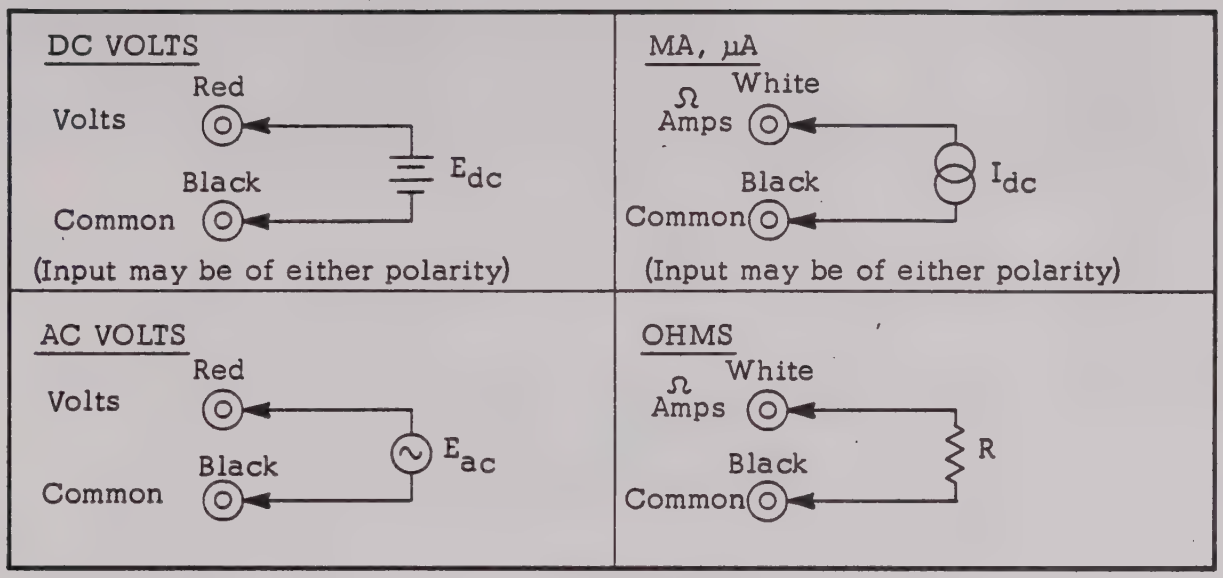


Figure 2.2 - Signal Input

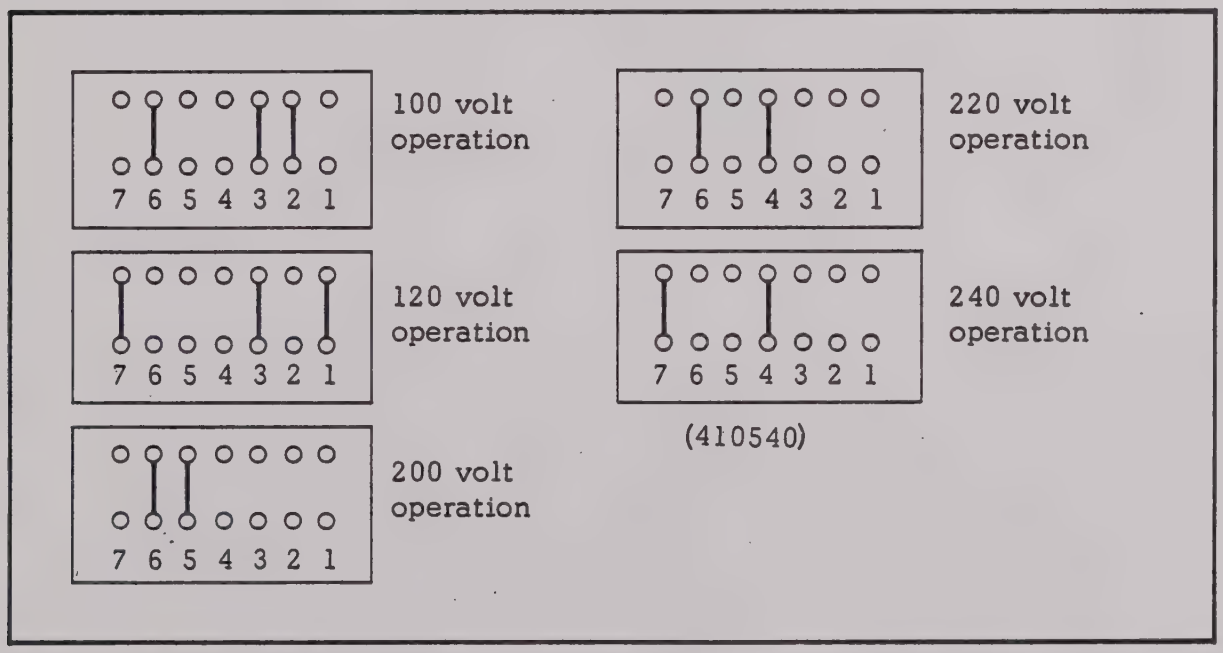


Figure 2.3 - Line Voltage Taps

indicators appearing at a 50-50 ratio.

2.23 EXPORT TRANSFORMER

2.24 Instruments designated 3800-E are equipped with a special transformer and jumper matrix, allowing the user to adapt the instrument for operation on various line voltages. In figure 2.3 are shown the proper jumper placement on the power matrix board for each line voltage. The matrix board Assembly No. 410540 is mounted directly to the power transformer.

CAUTION

Do not exceed the following minimum overload voltages:

DC ± 1000 volts all ranges

AC 500 volts AC RMS or DC

OHMS 70 volts AC RMS or DC on the 100 ohm range
125 volts AC RMS or DC on the 1K and 10 Kohm ranges
500 volts AC RMS or DC on the 100K, 1000K and 10 Megohm ranges

CURRENT 2.2 amps on the 100 and 1000 MA ranges
70 MA on the 1 and 10 MA ranges
7 MA on the 10 and 100 μA ranges

To clean the glass on the readout panel, use a commercial glass cleaner such as Windex. Do not use alcohol or other cleaners containing ketones.

SECTION 3

ELECTRICAL OUTPUT

3.1 GENERAL

3.2 The Option 1 electrical output transforms the readout, range, and polarity data into binary form for operating printers and other digitally operated equipment. The output of the Option 1 is non-isolated; equipment having floating inputs therefore, should be used with the option to retain the common mode rejection characteristics of the DMM.

3.3 MECHANICAL DESCRIPTION

3.4 All components of the Option 1 electrical output are located on a single printed circuit board which is mounted and hand wired to the DMM circuit board. The output data is taken from a covered shielded edge-connector, mounted to the back panel of the DMM.

3.5 ELECTRICAL DESCRIPTION

3.6 The electrical output is positive true, 1-2-4-8 BCD coding. All outputs, with the exception of the decimal output, are from RTL integrated circuits; the decimal position data is generated by discrete components. A typical output is shown in figure 3.1. Four control lines are provided, two are used for providing external command and two lines indicate when the binary data is available for reading. A simplified drawing of the control logic is shown in figure 3.2. The instrument is inhibited from internally initiating new readings by setting the HOLD line (pin 12) false. Setting HOLD false disables the rate generator. The DMM displays the previous reading as long as the hold line remains true, or until the instrument is externally commanded to take a new reading. The DMM command line (pin A) is held to +4 volts by the pull-up resistor R12. A new reading is externally generated by shunting the DMM Command line to common. A DMM Command is inverted by M1 and sets the Q output of the R-S f/f false, enabling the internally generated 60 Hz line sync pulse to be applied to the DMM rate circuitry. The R-S f/f is reset by the print pulse. The PRINT line goes true following a complete measurement cycle by the DMM and indicates that the data from the electrical output is ready to be recorded. The print line remains true until a new measurement cycle is initiated. The PRINT line is true during the measurement cycle and goes false at its completion. It is used when a negative going print command is required. A new DMM command may be generated any time after PRINT goes true. The DMM will not generate a new reading however until the 60 Hz sync line goes false; thus limiting the maximum externally commanded repetition rate to approximately 17 milliseconds.

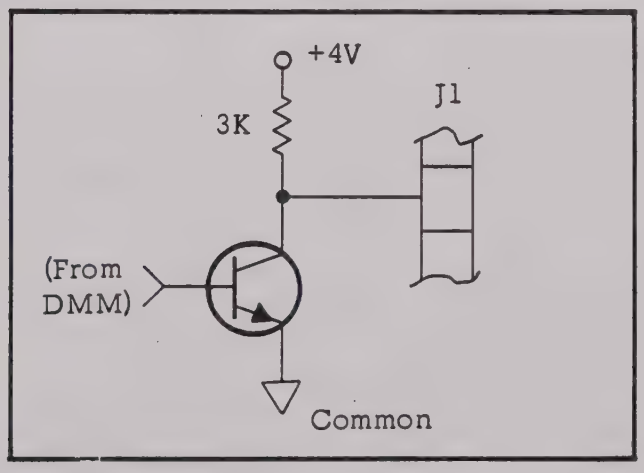


Figure 3.1 - Typical Option Output

3.7 COMMANDS

3.8 External commands may be generated by contact closure or by solid state switching. The HOLD and DVM COMMAND lines operate between +4 volts and common, making the OPTION-1 commands compatible with standard RTL and TTL circuitry.

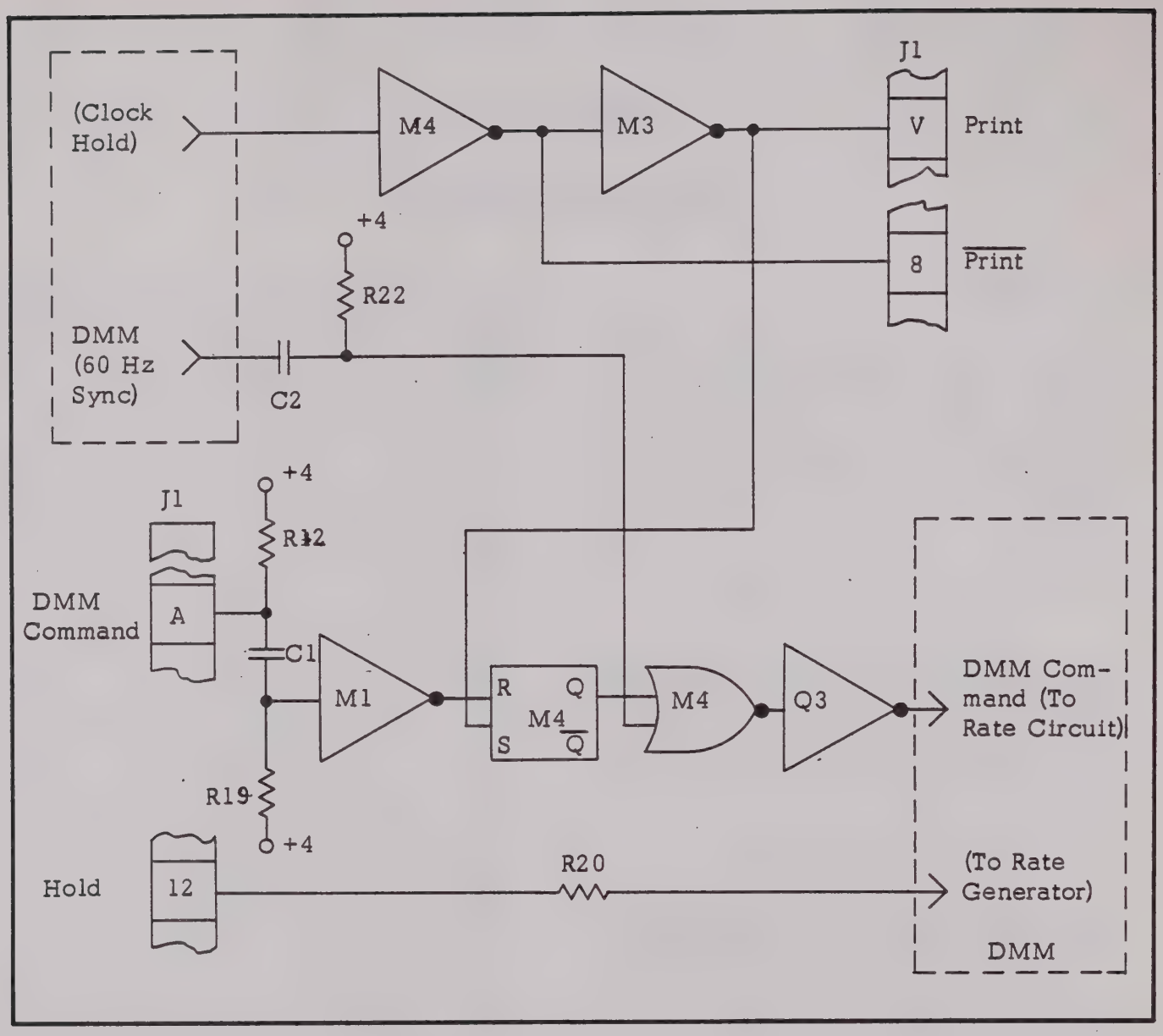


Figure 3.2 - Option Control Logic

Table 3.1 - Electrical Output Timing Diagram

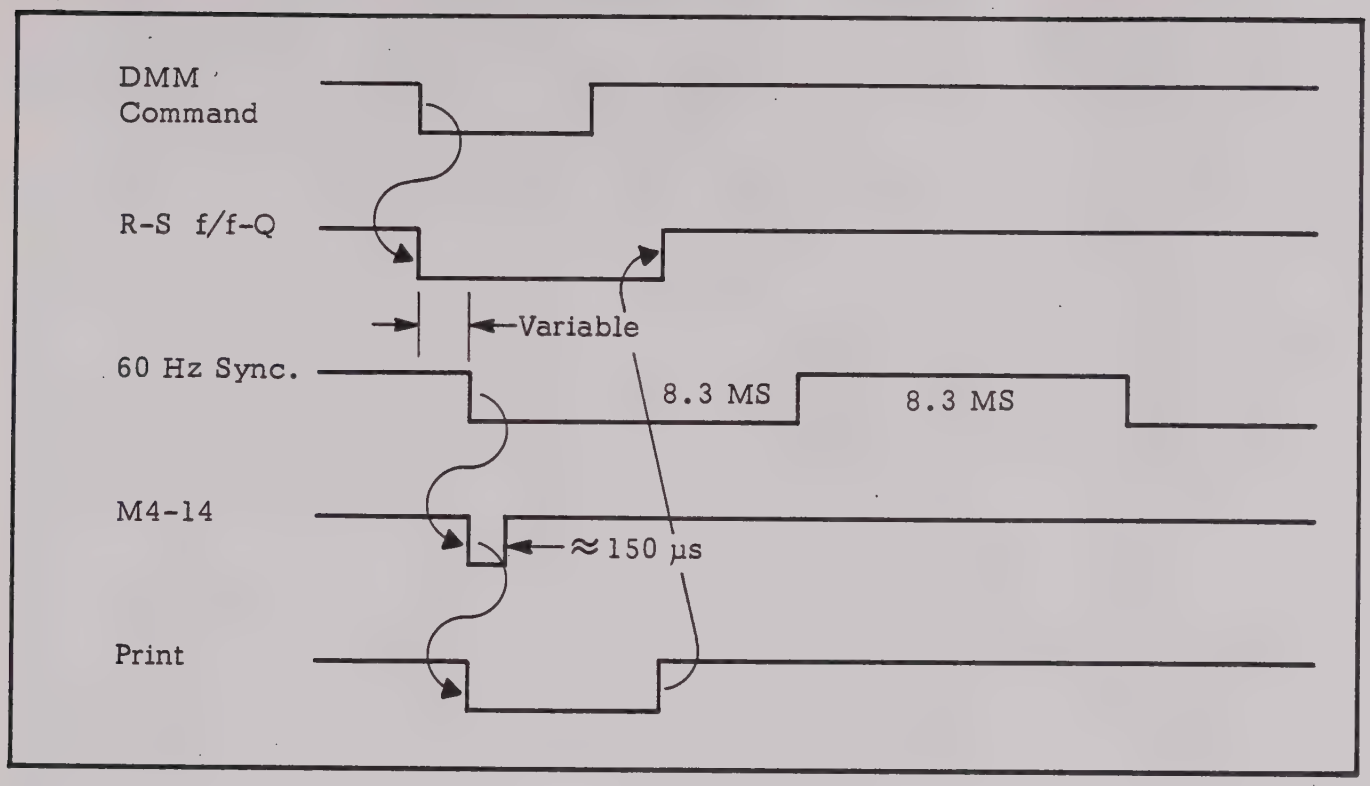


Table 3.2 - Output Connector

	DVM COMMAND	1's				10's				100's				OVERRANGE	POLARITY	OVERLOAD	1 RANGE	PRINT
		1	2	4	8	1	2	4	8	1	2	4	8	1				
J1	A	B	C	D	E	F	H	J	K	L	M	N	P	R	S	T	U	V
PINS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
	FOR OPTIONAL FUNCTION LINES						+4 VOLTS	$\overline{\text{PRINT}}$	10 RANGE	COMMON	100 RANGE	HOLD	FOR OPTIONAL RANGE LINES					

SECTION 4

THEORY OF OPERATION

4.1 GENERAL

4.2 This section describes the operation of the Model 3800 DMM. The section analyzes the instrument by its two basic sections; analog and digital. Contained in the section are drawings which are designed to simplify signal flow and are intended to supplement the drawings contained in Section 6.

4.3 Measurement. The Model 3800 DMM uses the dual slope integration method of analog to digital conversion. In this method, a DC input is converted into a proportional, negative current. The value of the current produced is a function only of the absolute value of the input signal, being independent of the polarity of the input signal. The current generated is fed to a capacitor which integrates the current, developing a linearly increasing negative charge as shown in figure 4.1a. The negative current is applied to the capacitor for a specific time period. The time period (T0-T1) is controlled by a clock driven counter in the digitizing and display portion of the DMM and is equal to 1000 clock cycles. At the completion of this signal integration period (T1), the voltage developed across the integration capacitor represents the value of the input signal. The voltage stored across the capacitor is converted into a proportional time period by

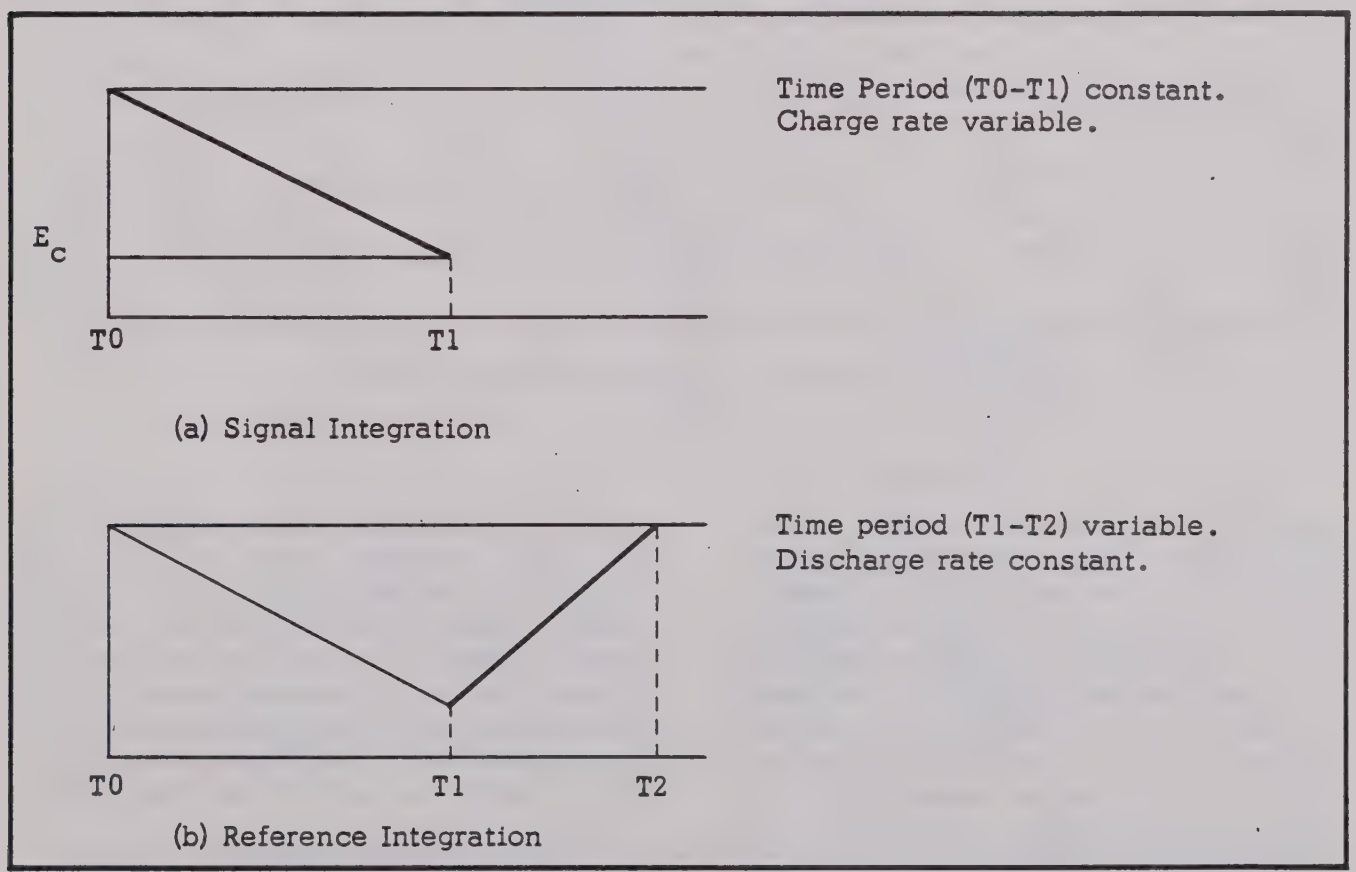


Figure 4.1 - Dual Slope Integration

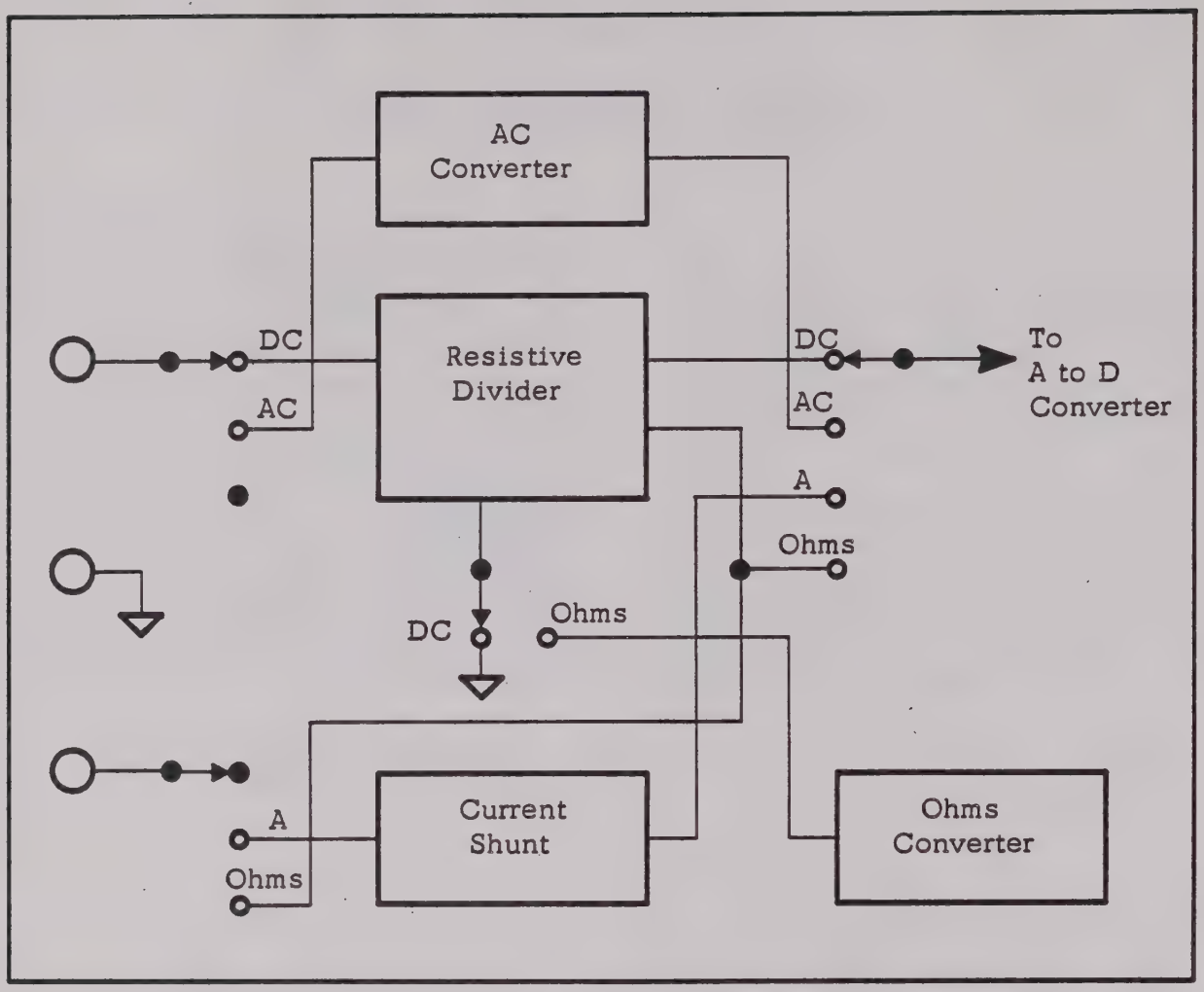


Figure 4.2 - Block Diagram - Signal Conditioning Section

replacing the input current with a known, positive, reference current. The positive current causes the voltage across the capacitor to linearly decrease as shown in figure 4.1b. This reference integration period (T1-T2) terminates when the voltage across the capacitor is restored to its original, premeasurement level (T0). The start of the reference integration period (T1) coinsides with the counter being set to 0000 and the completion of the period (T2) halts the counter. The reference integration period (T1-T2), which is proportional to the value of the input signal, controls the number of clock cycles registered by the counter. The value of reference current is opposite in polarity but equal in value to the signal current produced by a full scale input. For a full scale input (1 volt) the reference integration period (T1-T2) is equal to the signal integration period (T0-T2) and the counter registers 1000. For an 0.5 volt input the reference integration period is one half that for a full scale input and the counter registers 500. At the completion of the reference integration period the position of the counter is displayed and numerically represents the value of the input voltage.

4.4 SIGNAL CONDITIONING

4.5 Prior to measuring by the Analog to Digital section of the DMM, the input signal is converted to a maximum DC level of ± 1.2 volts. The

isolator portion of the A to D converter operates at a gain of one or ten depending on the range and function selected (see table 4.1). The scaled input is limited to ± 0.12 when the isolator operates at a gain of 10. The input signal is routed through the function control switch (S1) to the appropriate conditioning circuitry. The conditioned signal is routed again through S1 to the A to D converter.

Table 4.1 - Isolator Gain

Range	DC	AC	MA	μA	Ohms
.1	X10				X1
1	X1	X1	X10		X1
10	X1	X1	X1	X10	X1
100	X1	X1	X10	X1	X1
1000	X1	X1	X1		X1
10,000					X10

4.6 DC

4.7 The DC input is applied to the range divider where it is scaled and routed to the A to D converter. On the .1 and 1 volt ranges, no attenuation of the signal takes place. On the 10, 100 and 1000 ranges the input signal is scaled by a factor of .1, .01 and .001 respectively. The additional resolution required for the .1 range is supplied by the isolator.

4.8 AC

4.9 The AC Converter, shown simplified in figure 4.3, converts an AC input to an equivalent DC signal. The AC signal is scaled by the AC Converter attenuator by a factor of .5 on the one volt range and by .05, .005, and .0005 on the 10, 100 and 1000 volt ranges respectively. The scaled input is amplified by the potentiometric amplifier consisting of transistors Q10 through Q14. The amplified

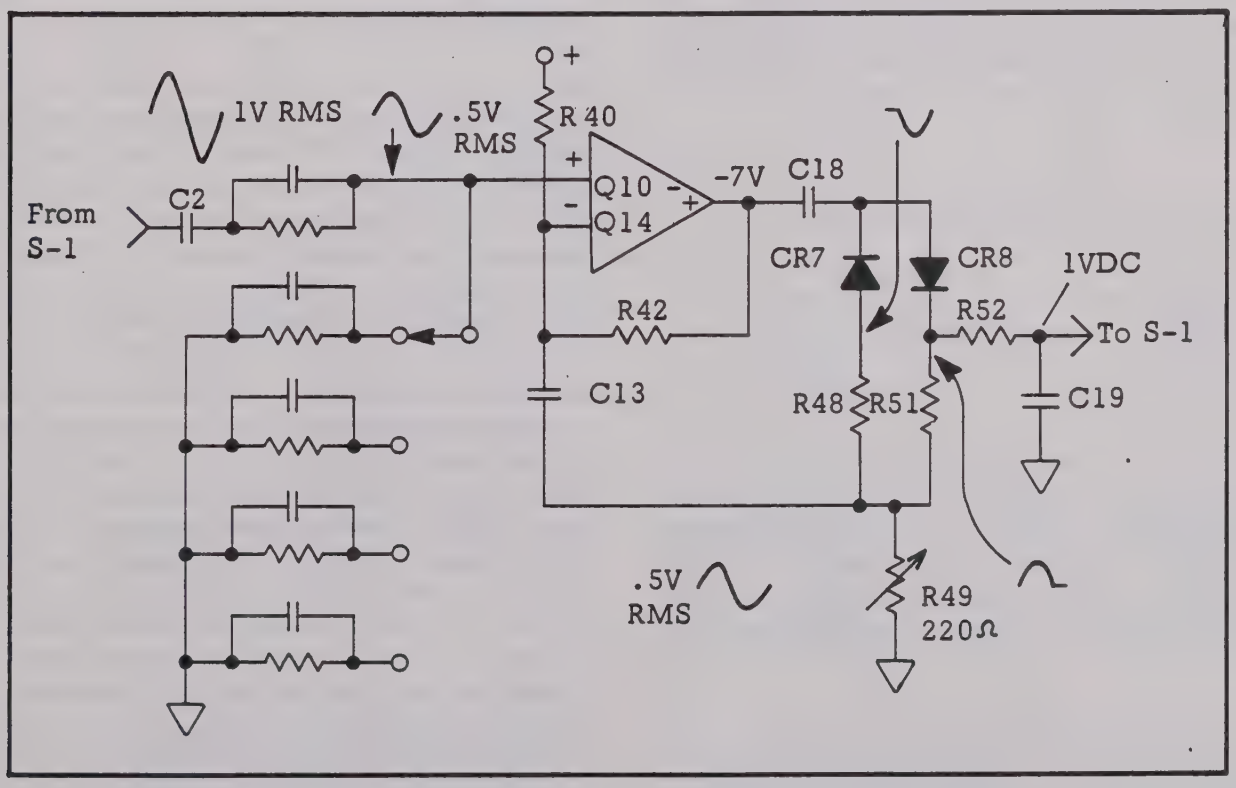


Figure 4.3 - Simplified AC Converter

AC signal is fed through C18 to two polarity dependent feedback paths, CR7 and R48, and CR8 and R51. Each path conducts during one half of the AC signal. The bisected signal is summed across R49 and fed back through capacitor C13 to the reference input of the amplifier. The closed loop gain of the amplifier determined by R48, R49, and R50 is approximately 4.5. The positive half cycle developed across R51 is filtered by R52 and C19 to produce a positive DC equivalent of the AC input. Further filtering is performed on the DC output by the active filter of the Analog to Digital converter section.

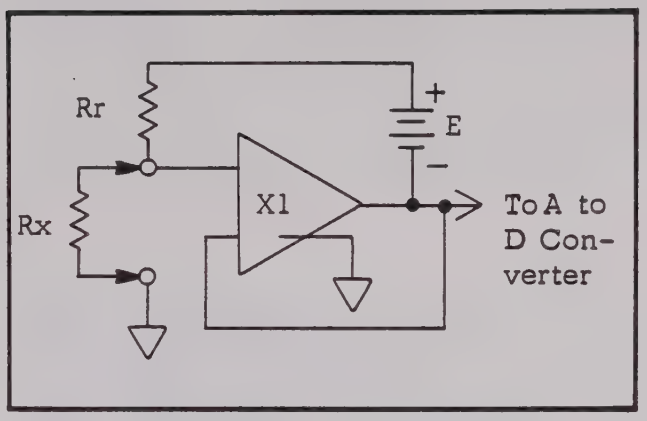


Figure 4.4 - Basic Ohms Converter

4.10 OHMS

4.11 The ohms converter produces a precise current which is fed through the resistance being measured. The resultant voltage drop across the resistor is measured and displayed. The current generated for each range is chosen to produce a one-volt drop across a resistance equal to the range selected. Thus, on the 1K range, a current of 1 milliamp is produced developing a one-volt drop across an input resistance of 1 Kohm. The current produced on each range is given in table 4.2.

Table 4.2 - Ohms Converter Current Output

RANGE	CURRENT
100 Ohms	10 MA
1 Kohms	1 MA
10 Kohms	100 μA
100 Kohms	10 μA
1 Megohm	1 μA
10 Megohms	100 na

4.12 A simplified diagram of the ohms converter is shown in figure 4.4. The voltage developed across the resistance being measured (Rx) is buffered by a gain of one amplifier. The ohms converter generates a precise voltage (E) referenced to the amplifier output. The voltage is connected to a precise range resistor (Rr) and (Rx), connected in series. Because the voltage (E) follows the voltage developed across (Rx), the voltage impressed across (Rr) is constant, making the current through (Rx) constant. The input resistance of the gain of one amplifier is extremely high. Effectively, therefore, all of the current flowing through (Rr) also flows through (Rx).

4.13 For measuring ohms, the converter is used in conjunction with other portions of the DMM circuitry as shown in figure 4.5. The Isolator from the A to D Converter provides the required isolation and precise gain-of-one accuracy for monitoring the voltage drop across resistor Rx. The output of the isolator is buffered by a gain of one amplifier (consisting of transistors Q1 through Q4) on the ohms converter. To the output of the buffer amplifier is connected a network producing two precise voltage outputs. The network consists of a current generator Q5, which is referenced to the DMM's + REFERENCE VOLTAGE, driving a stable 0.5 milliamps through resistors R20 and R22, connected in series. The voltage drop across R22 is +1 volt and is used only on the 10 Meg range. The voltage drop across the two resistors is +5 volts. This level is increased to +10 volts by a gain-of-two amplifier consisting of transistors Q6 through Q9; the 10 volt level is used on all ranges except the 10 Meg range. Both the +1 volt and +10 volt levels float above the DMM input level.

4.14 The converter voltage output is routed through a precision, series-divider, consisting of the same resistive string used for the DC range divider.

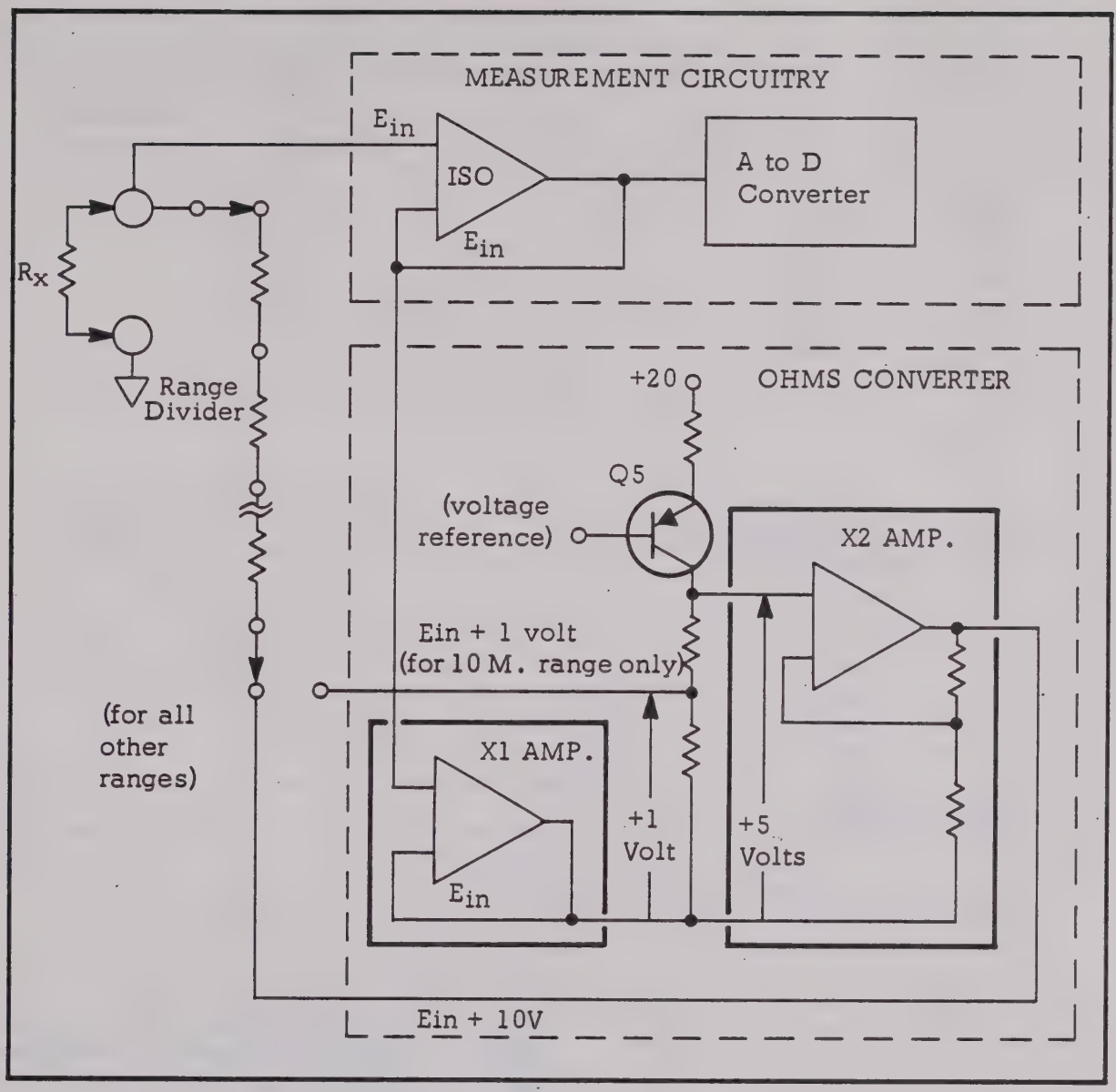


Figure 4.5 - Simplified Ohms Converter

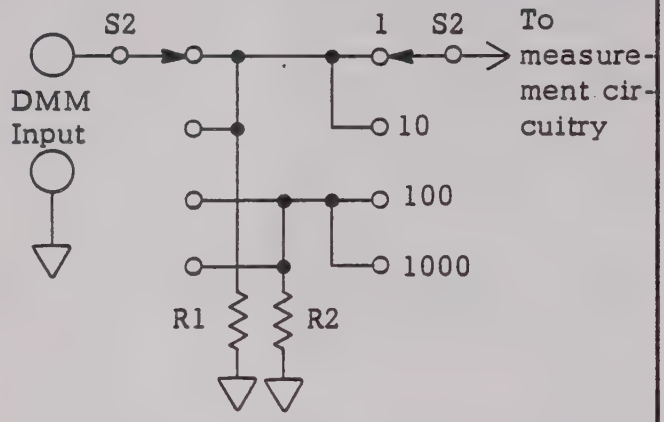
The Range Control selects the amount of resistance (Rr) placed in series with the converter voltage output and Rx, thereby controlling the current produced for each range.

4.15 DC CURRENT

4.16 Two current positions, milliamp and microamp, are provided on the series 3800 DMM. Both functions are internally selected shunts to convert the input current to an equivalent voltage for measurement. As shown in figure 4.6, two shunt resistors are used for the milliamp function and one shunt for the microamp function. The gain of the A to D converter is increased to provide the required resolution on the 10 microamp, 1 milliamp and 100 milliamp ranges.

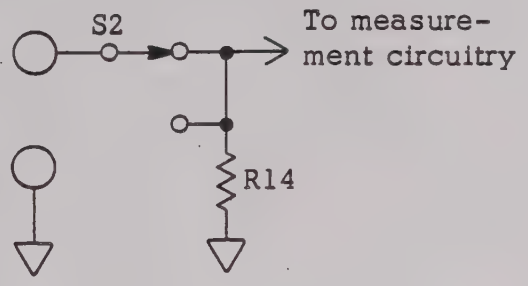
4.17 ANALOG TO DIGITAL CONVERTER

4.18 The Analog to Digital (A to D) converter shown in figure 4.7, converts the input signal to a



RANGE	A TO D GAIN
1	X10
10	X1
100	X10
1000	X1

Milliamp Circuit



RANGE	A TO D GAIN
10	X10
100	X1

Microamp Circuitry

Figure 4.6 - Simplified DC Current Circuits

proportional time period for measurements by the digital section.

4.19 FILTER

4.20 The active bessel-type filter shown simplified in figure 4.8 provides 60 dB of normal mode rejection at or near 60 Hz and consists of transistor Q15 and Q16. The transistors provide a moderately high degree of amplification and through the feedback path (R54, R57, C20 and C22) operate with the source impedance to produce an active 3-pole filter.

4.21 ISOLATOR

4.22 The isolator is a high gain, high input impedance, DC amplifier, consisting of a differential, dual FET (Field Effect Transistor) input stage, driving an integrated circuit amplifier. The isolator (shown in figure 4.9) is operated potentiometrically to provide a closed-loop gain of one. The signal input of the isolator is clamped by transistors Q50 and Q51, connected as diodes, to limit the input signal swing to approximately plus or minus 3 volts.

4.23 SIGNAL CURRENT GENERATORS

4.24 The signal current generators operate with the isolator to produce a negative current proportional to the isolator input voltage. One converter operates only during positive inputs and the other only during negative inputs. Shown in figure 4.10 is a simplified schematic of the positive signal current generator. Transistors Q20 and Q21 are connected in a Darlington configuration and may be considered as a single, extremely high beta

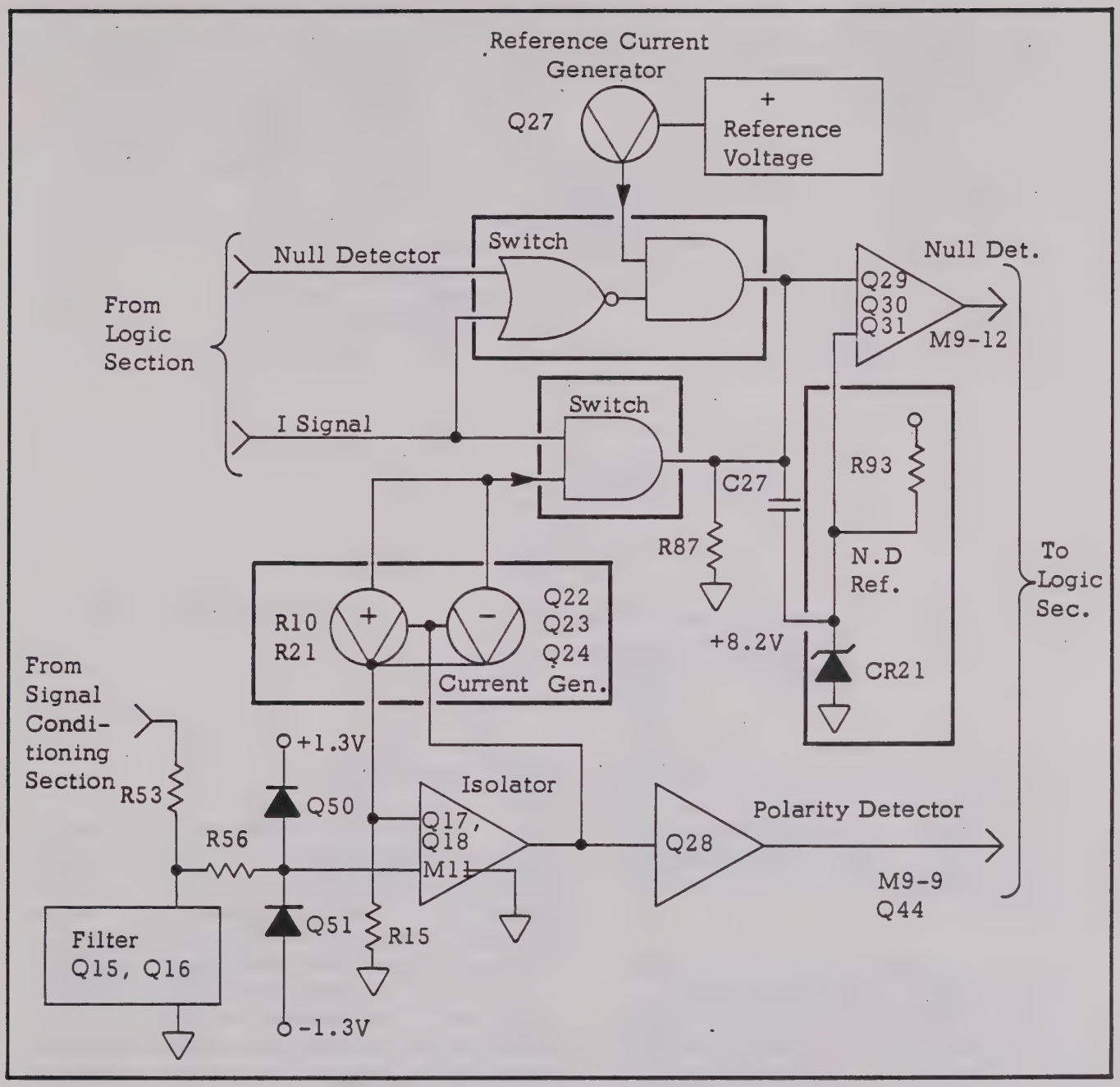


Figure 4.7 - Analog to Digital Converter

transistor. A positive level at the input of the isolator produces a high amplified, positive output to the base of Q20-Q21 causing it to conduct. Current flows through the current gain resistor causing a positive I-R voltage drop to develop across the resistor. The network stabilizes when the I-R drop is equal to the positive isolator input level. The current flowing through the resistor is equal to the positive isolator input level. The current flowing through the resistor is equal (for

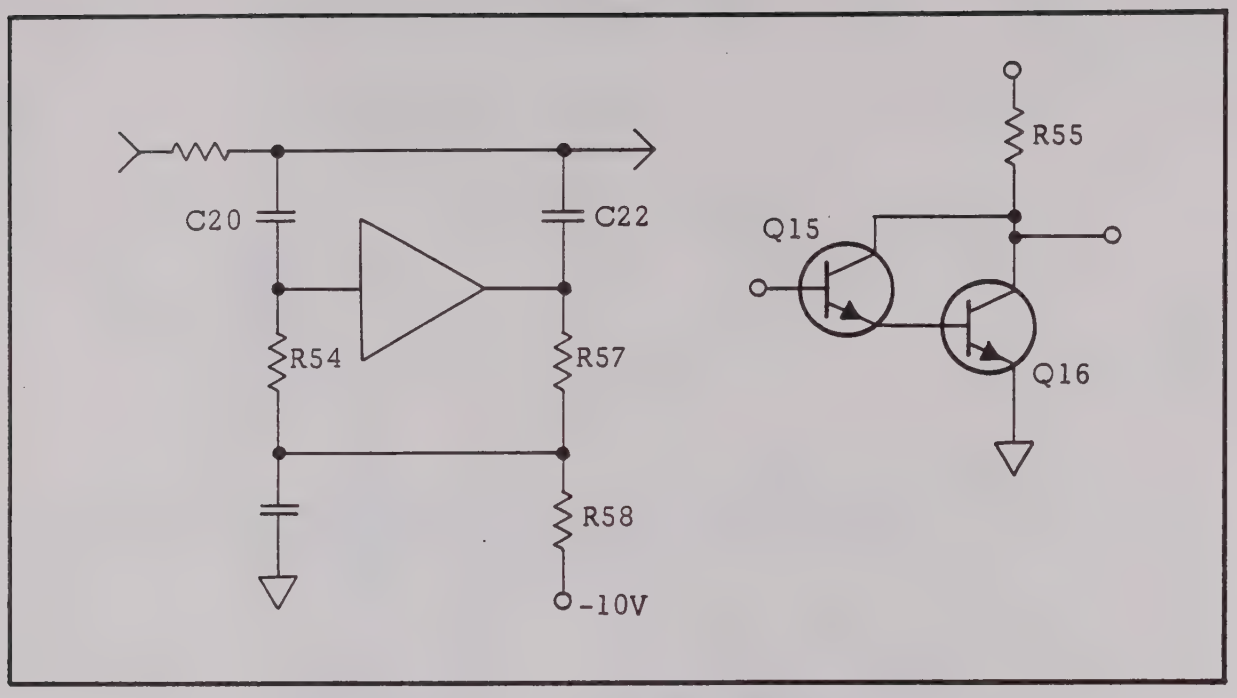


Figure 4.8 - Simplified Filter Schematic

all practical purposes) to the current drawn by the Q20-Q21 collector. The current through the current gain resistor varies directly with the isolator input, making the current drain (negative current) from Q20-Q21 directly proportional to the isolator input.

4.25 The negative signal current generator shown in figure 4.11 consists of transistors Q22, Q23 and Q24. Transistors Q22 and Q24 have matched characteristics and the emitter circuits are balanced, causing the transistors to draw equal amount of current when conducting. When the input of the isolator is negative, the amplified negative output drives transistor Q23 on, driving current into the bases of Q22 and Q24. The current through Q22 flows also through the gain resistor developing a negative I-R drop across the resistor. The circuitry stabilizes when the negative voltage drop across the gain resistor equals the negative isolator input level. The current drain (negative current) developed by Q24 forms the output of the negative signal current generator and is equal to the current drawn by Q22. It is therefore directly proportional to the negative isolator input.

4.26 GAIN CIRCUIT

4.27 The gain circuit determines the amount of negative current generated by the signal current generators. Normally the gain is determined by R15 (2K) which produces a signal current output of 0.5 milliamps for a ± 1 volt input to the isolator. On certain function-range combinations R15 is shunted by R19, lowering the combined resistance to 200 ohms. This increases the amount of current produced by the signal current generator by a factor of 10. Function range combinations are given in Table 4.1.

4.28 VOLTAGE REFERENCE SOURCE

4.29 The voltage reference source provides a precise and stable, positive DC level for the reference current generator and ohms converter. The reference is a selected zener diode, biased for a zero temperature coefficient.

4.30 REFERENCE CURRENT GENERATOR

4.31 The reference current generator (Fig-

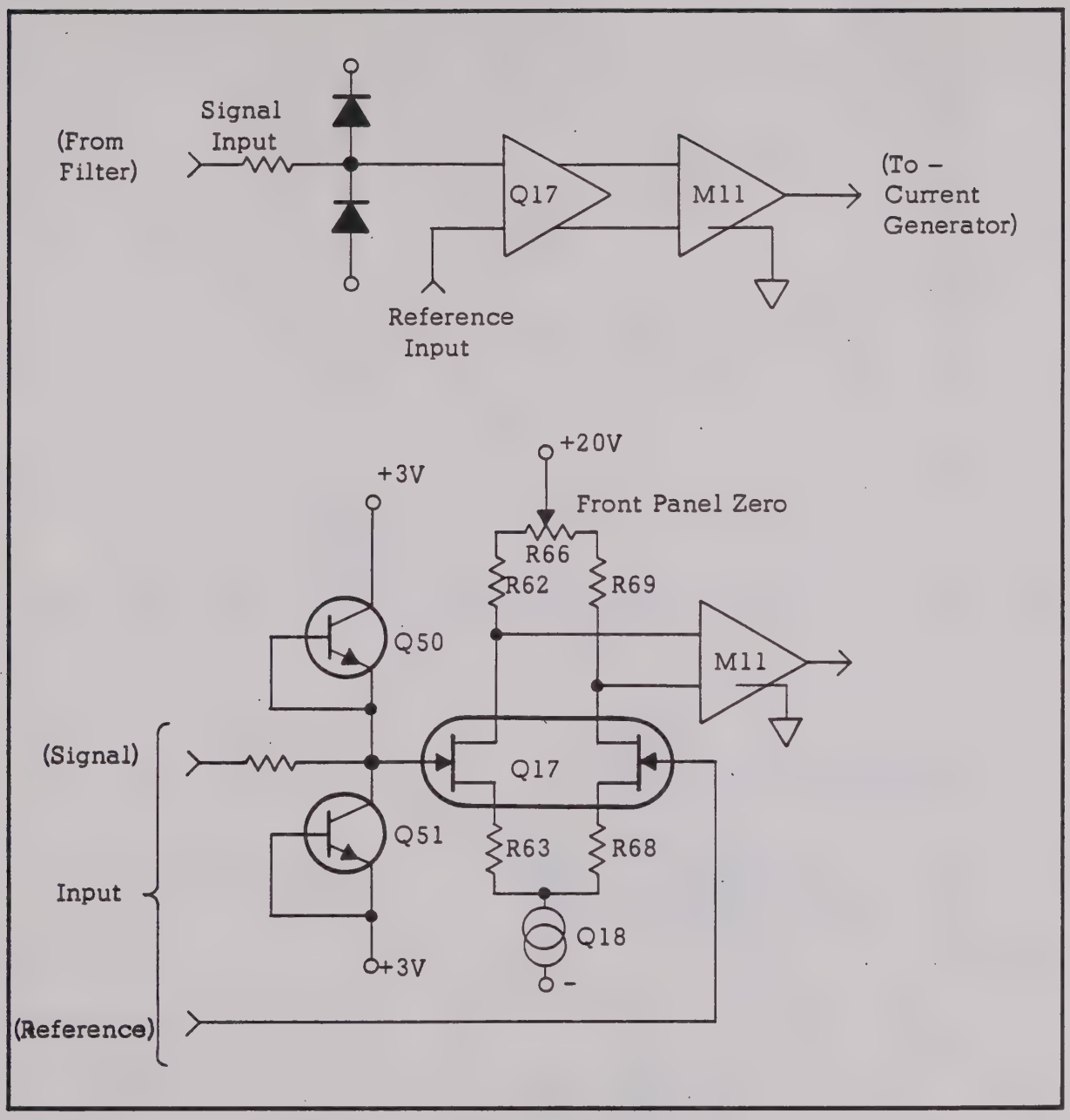


Figure 4.9 - Block Diagram - Isolator/Amplifier

ure 4.12) produces a stable and highly accurate, positive current of 0.5 milliamps. The converter consists of transistor Q27 biased through CR20 to the voltage reference source, and emitter resistors R85, R86. Resistor R85 is set to allow 0.5 milliamps of positive current to flow through Q27. Diode CR20 provides temperature compensation for the reference current generator and ohms converter current generator.

4.32 SIGNAL CURRENT GATE

4.33 The signal current gate controls the flow of current from the signal current generators, routing

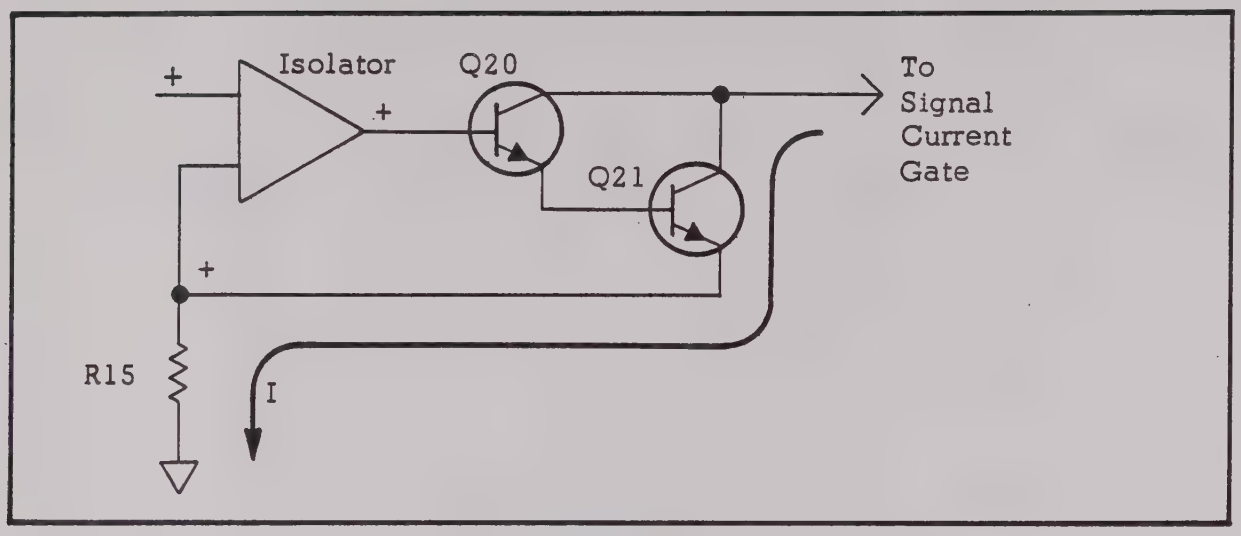


Figure 4.10 - Positive Input Signal Current Generator

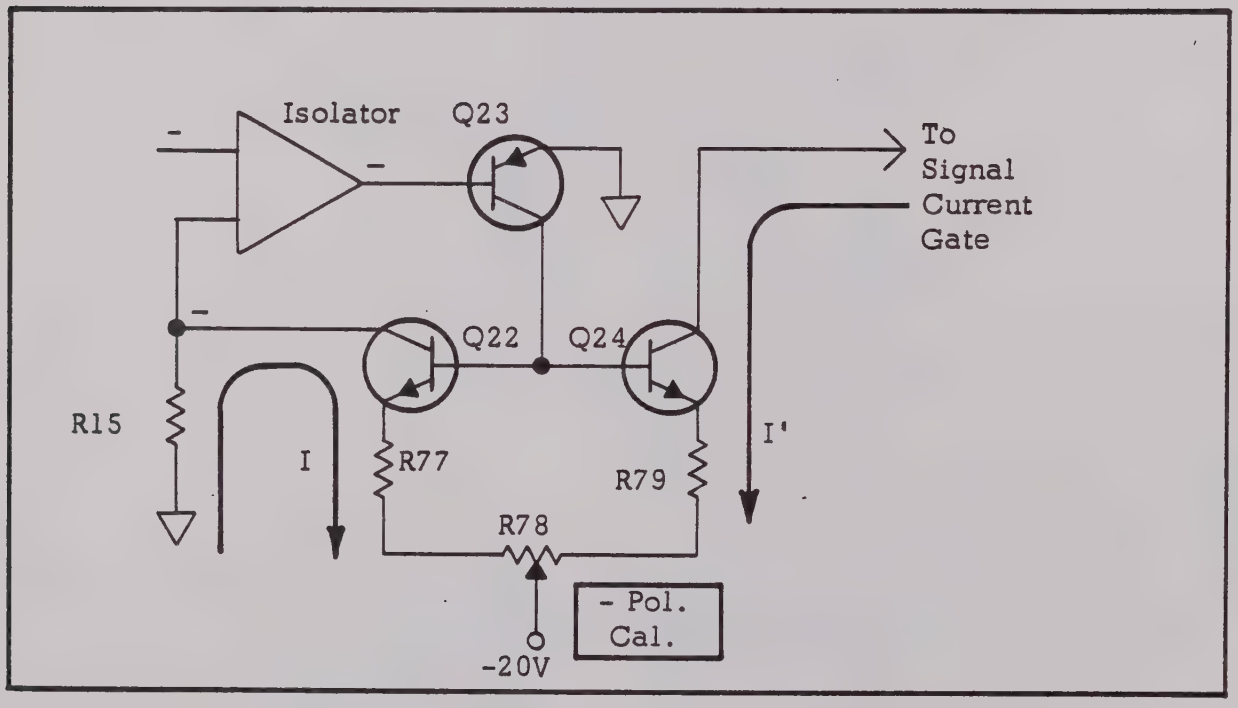


Figure 4.11 - Negative Input Signal Current Generator

the flow to the integrator capacitor or to a positive supply. The signal current gate is operated by I SIGNAL from the logic section of the DMM. The basic circuitry of the gate is shown in figure 4.13a. During the time that I SIGNAL is true, transistor Q19 is turned on, holding gate diode CR15 to approximately +0.2 volts.

When I SIGNAL is false, CR15 is held to +10 volts by zener CR35. The current flow through the gate is shown with Q19 conducting in figure 4.13b. CR15 is back-biased prohibiting current flow; CR17 is forward-biased, allowing all of the current from the signal current generators to flow into the integrator capacitor. With Q19 off, the

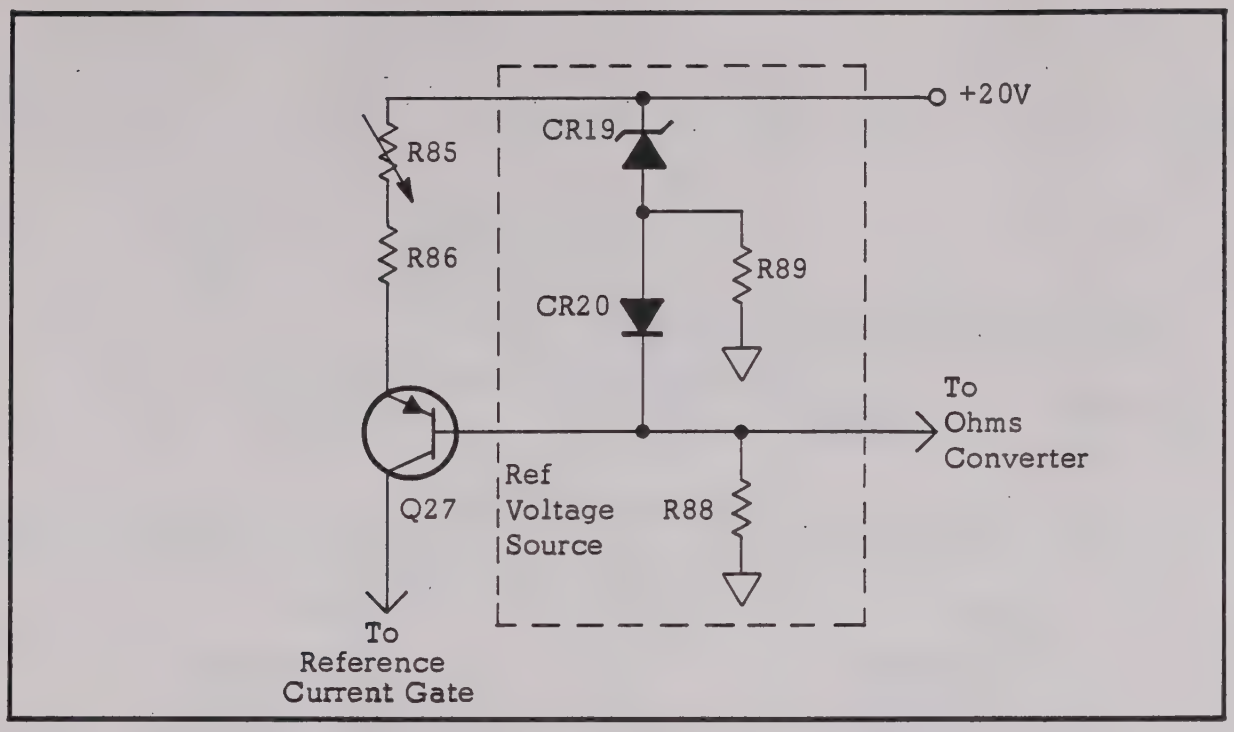


Figure 4.12 - Reference Current Generator

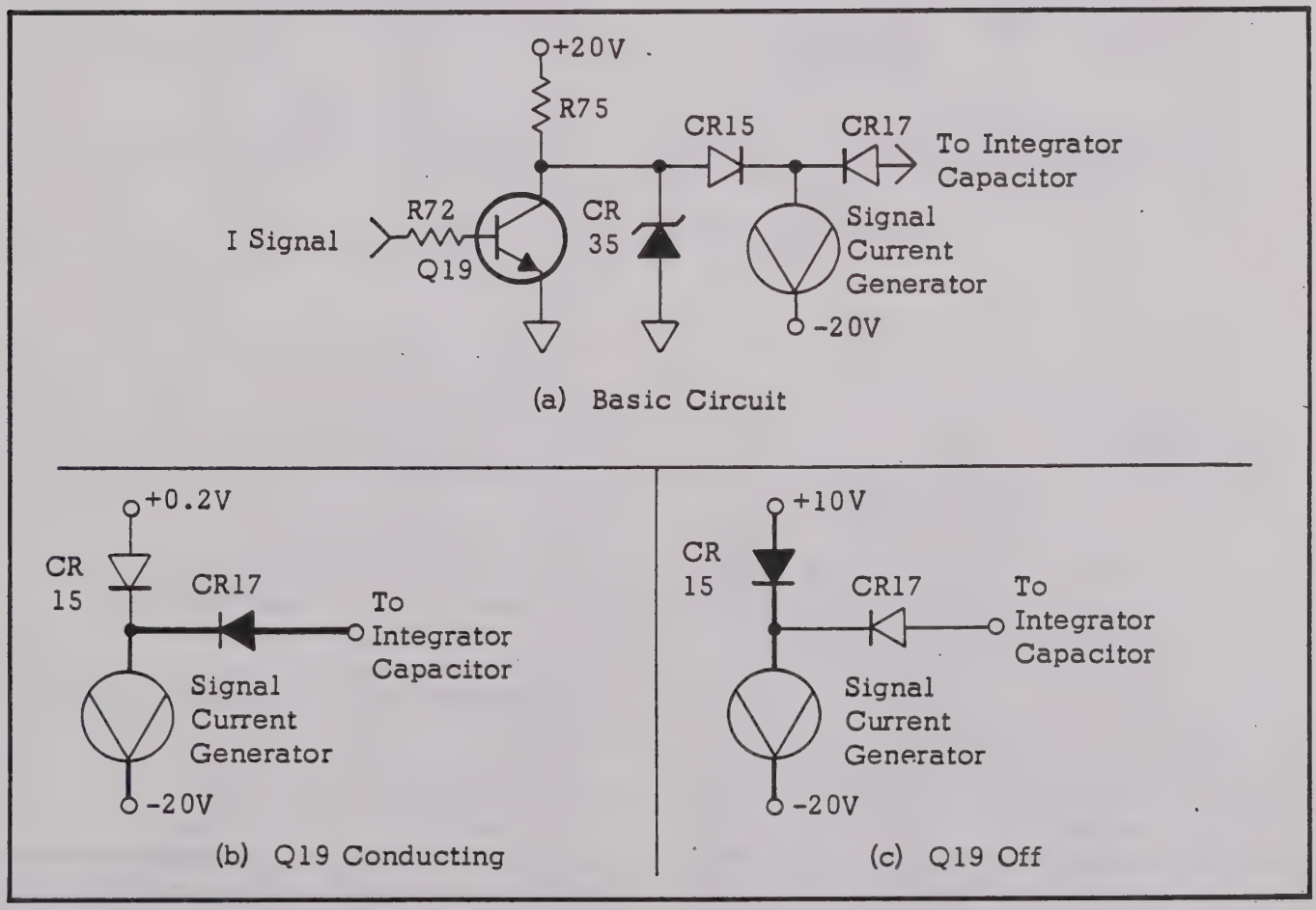


Figure 4.13 - Simplified Signal Gate Circuit

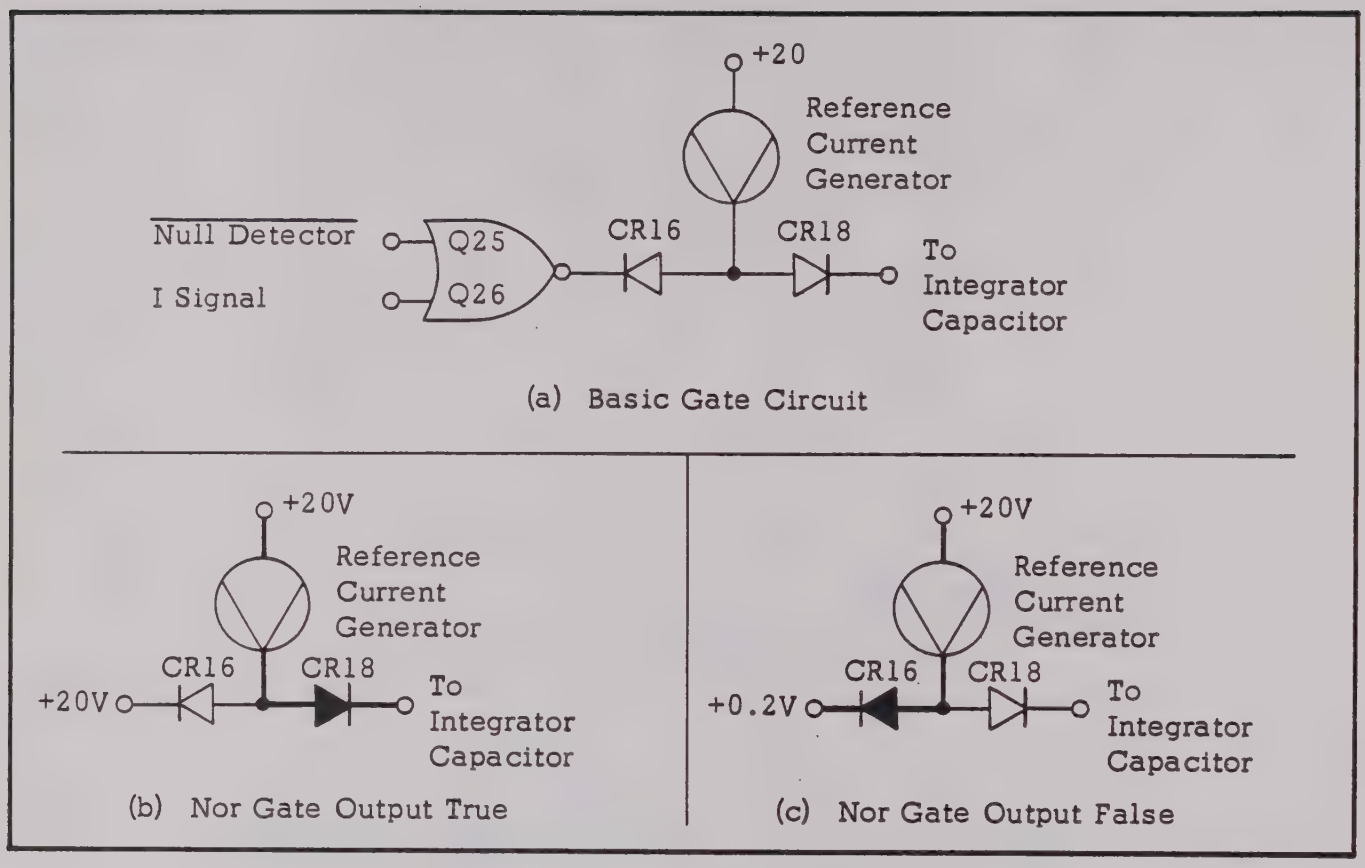


Figure 4.14 - Reference Control Gate Circuit

operation is reversed and all of the current flow is through diode CR15.

4.34 REFERENCE CURRENT GATE

4.35 The reference current gate controls the flow of current from the reference current generator, routing the flow to the integrator capacitor or to analog common. The reference current gate is operated by a NOR gate consisting of transistors Q25 and Q26. When input lines NULL DETECTOR and I SIGNAL are both false the nor gate output is +20 volts; when either input line is true the nor gate output is +0.2 volts. Both nor gate input lines are generated in the logic section. The basic circuitry of the gate is shown in figure 4.14a. During the time both NULL DETECTOR and I SIGNAL lines are false the cathode of CR16 is held to +20 volts. When either or both of the input lines are true, the cathode of CR16 is held to +0.2 volts. Figure 4.14b shows the current flow through the gate with the nor gate output true. CR16 is back-biased, prohibiting current flow; all of the current from the reference current generator flows through forward-biased CR18. In figure 4.14c, current flow is shown with the nor gate output false. Current flows through forward-biased CR16 and no current flows through bac-biased CR18.

4.36 INTEGRATOR CIRCUIT

4.37 The integrator circuit converts the currents from the signal and reference generators into the dual slope ramp shown in figure 4.1. During the signal integration period, the integration capacitor

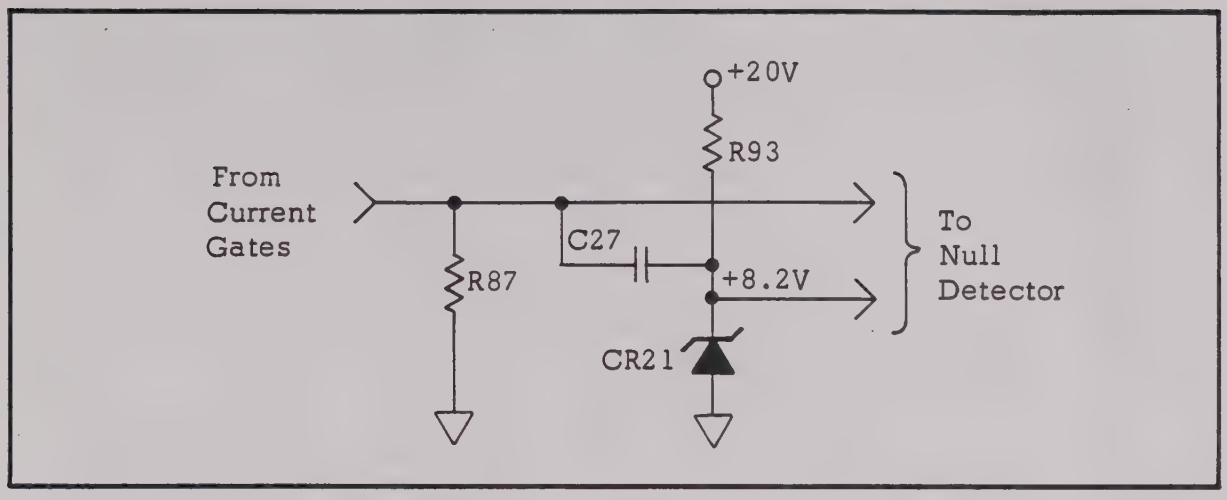


Figure 4.15 - Integrator Circuit

(C22) is charged negatively by the negative current from the signal current generator flowing through the signal current gate. The capacitor is then discharged by the positive current from the reference current generator through the reference gate. As shown in figure 4.15, the capacitor is referenced to +8.2 volts by zener CR21. The positive level produces required bias for the null detector circuit and simplifies the deisng requirements for the current gate circuits. Resistor R87 provides a very high resistance shunt (100 Megohms), for C27. During the measurement cycle, the resistor does not affect the operation of the circuitry. When the instrument is placed in external HOLD (on DMM's equipped with Option 1) for long periods of time, the R87 operates in conjunction with the null detector and reference current to hold the capacitor at its operating level.

4.38 NULL DETECTOR

4.39 The null detector monitors the voltage across the integrator capacitor, and converts the integration time period into a digital output. The null detector produces a true (positive) output whenever the voltage across the integrator capacitor is below a positive operating level determined by the null detector, and a false output when the capacitor voltage is equal to or above the operating level.

4.40 The null detector circuit is shown simplified in figure 4.16. The input of the null detector is a junction FET (Q29), providing an extremely high input impedance to the integrator circuit. The source of the FET is biased to +8.2 volts by zener CR21 of the integrator circuit, holding the cutoff point of the FET above ground. The FET drives Q30 which inverts and amplifies the FET output. Q30 in turn drives a single stage inverting amplifier Q31.

4.41 The operating level of the null detector (the point at which the null detector changes state) is equal to the +8.2 voltage bias at the FET source, less the inherent cutoff point of the junction FET; the cutoff point of the junction FET varies from one device to another. The operating point therefore may lie anywhere between +2V and +6V. The level of the operating point however, does not require compensation, nor does it alter the operation of the instrument.

4.42 POLARITY DETECTOR

4.43 The polarity detector monitors the output of the Isolator and generates a true logic level whenever the isolator output is negative. The polarity detector output drives the polarity indicator circuitry of the digitizing and display portion of the DMM. The detector is a single stage inverting amplifier consisting of Q28.

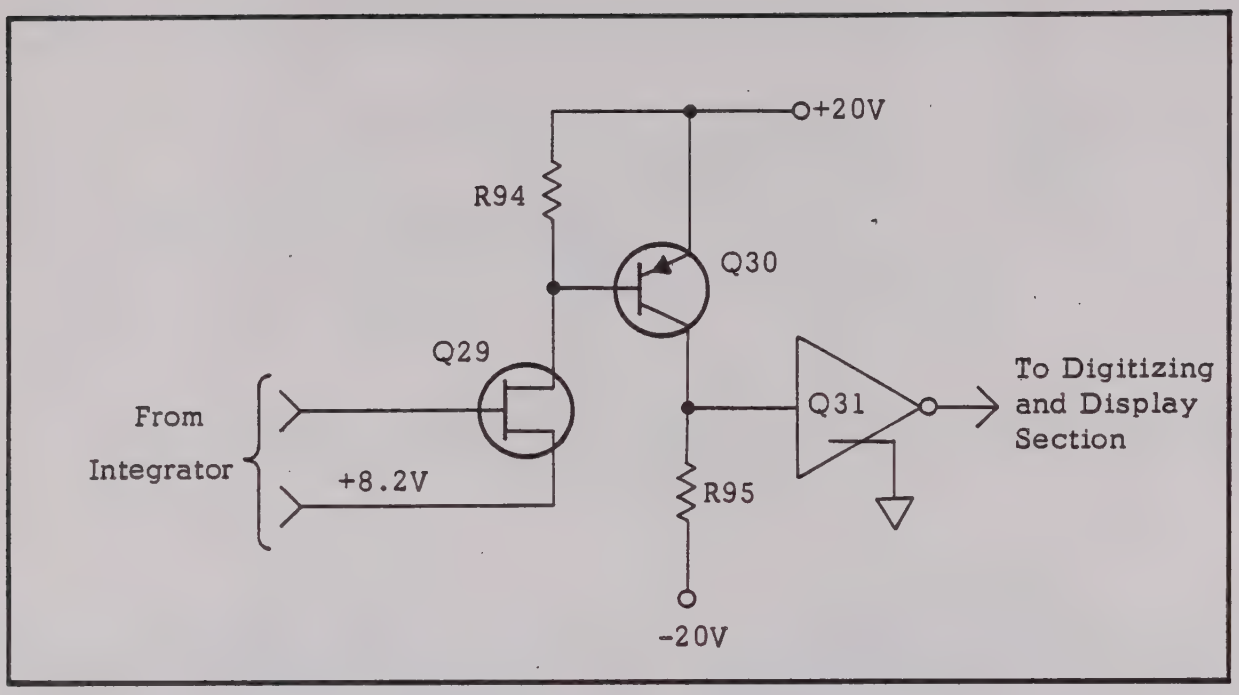


Figure 4.16 - Null Detector

4.44 DIGITIZING AND DISPLAY

4.45 The digitizing and display section measures the time required for the reference integration period and converts the measured time into a digital display. The D/D section also determines the time required for the signal integration period and establishes the number of readings taken per second.

4.46 General. The DMM readout voltage supply is an unfiltered, half-wave +200 volts. The readout tubes therefore are illuminated 60 times a second and only during each half cycle of the line voltage. The measurement cycle is synchronized with the line frequency and each measurement sequency takes place during a readout blank period (less than 8.3 ms). The instrument takes between four and five measurements each second.

4.47 Digitizing and Display Operation. The digitizing and display section is shown simplified in figure 4.17.

4.48 The D and D section consists of a binary counter, driven by a clock-oscillator. The counter advances at the clock rate (approximately 400 kHz) from 0000 to 1999 and then overflows to 0000. The clock runs during the entire integration cycle (T0-T2) and at the start of a measurement, the counter is set to 1000. During the signal integration period (T0-T1) the counter advances from 1000 until overflow at which time the signal integration period is terminated. The time required for the counter to advance from 1000 to 0000 (1000 clock cycles) determines the signal integration period. The counter continues from 0000 at the clock rate until the completion of the reference integration period (T1-T2). At this time the clock is stopped. The position of the counter is converted from binary data to 10-line data and displayed by the readout tubes.

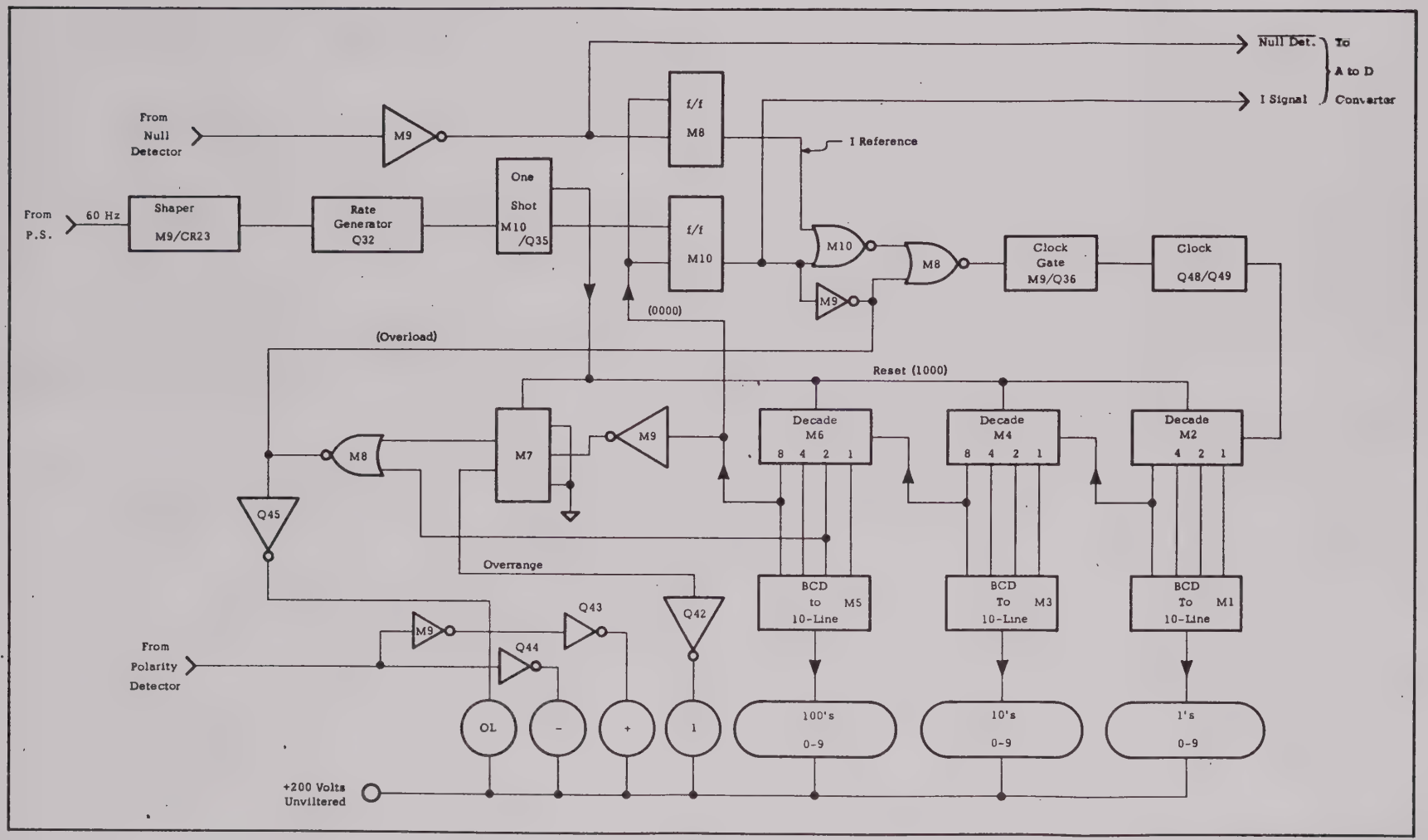


Figure 4.17 - D/D Section

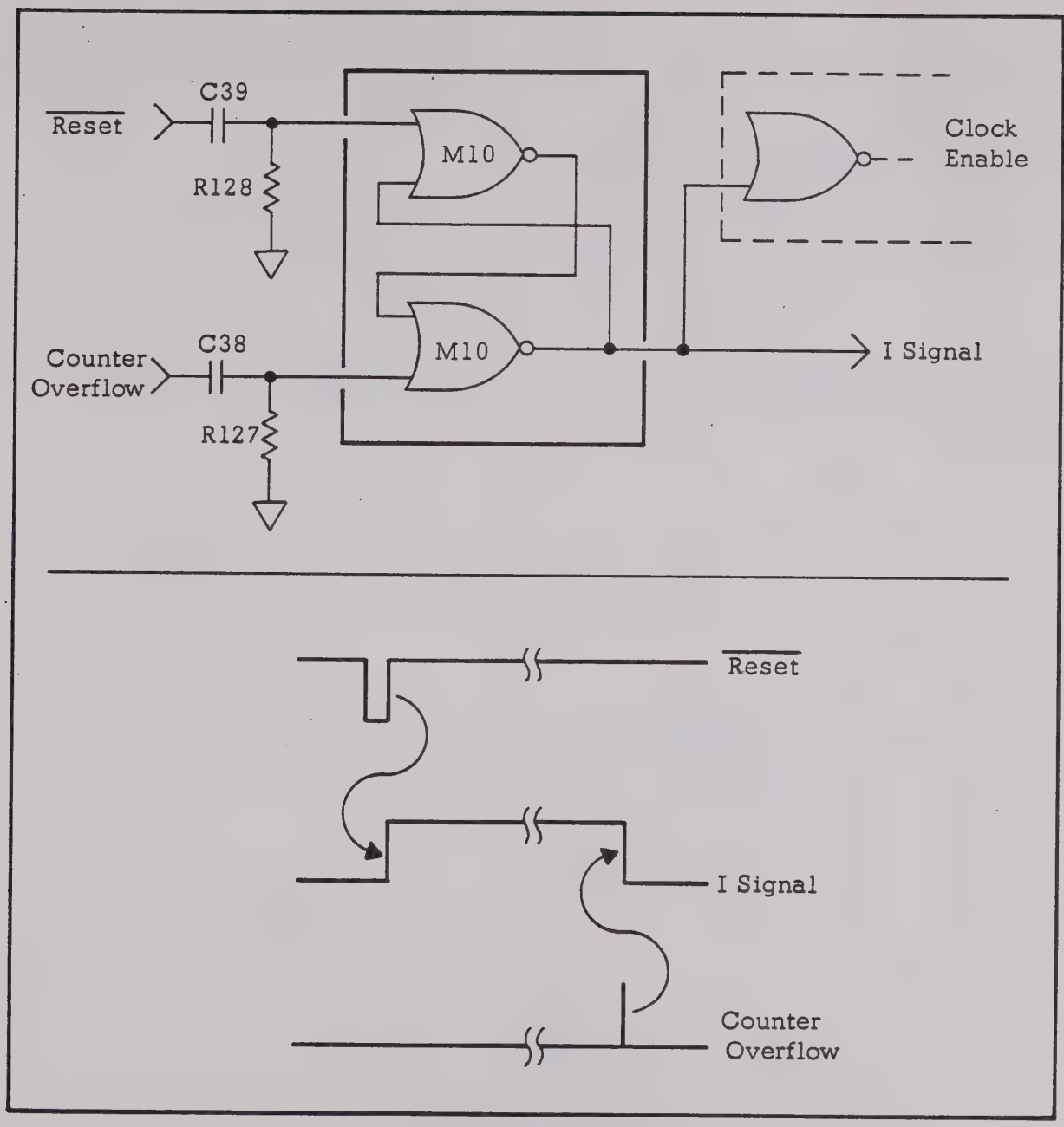


Figure 4.20 - I Signal f/f

4.49 SHAPER

4.50 A 60 Hz (line frequency) signal is monitored at the 25V winding of the power supply transformer and converted to a +4V -0 volts square wave by the shaper circuit as shown in figure 4.18. The circuit consists of a current limiting resistor R98, diode CR22 and inverter M19. During the time the 60 Hz input is negative, the current through R98 is shunted to ground and the inverter output is +4 volts. When the input is positive, the inverter is on with an output of zero volts. The shaper output is used to synchronize the rate generator, and on instruments equipped with Option 1, used in conjunction with the DMM command circuitry.

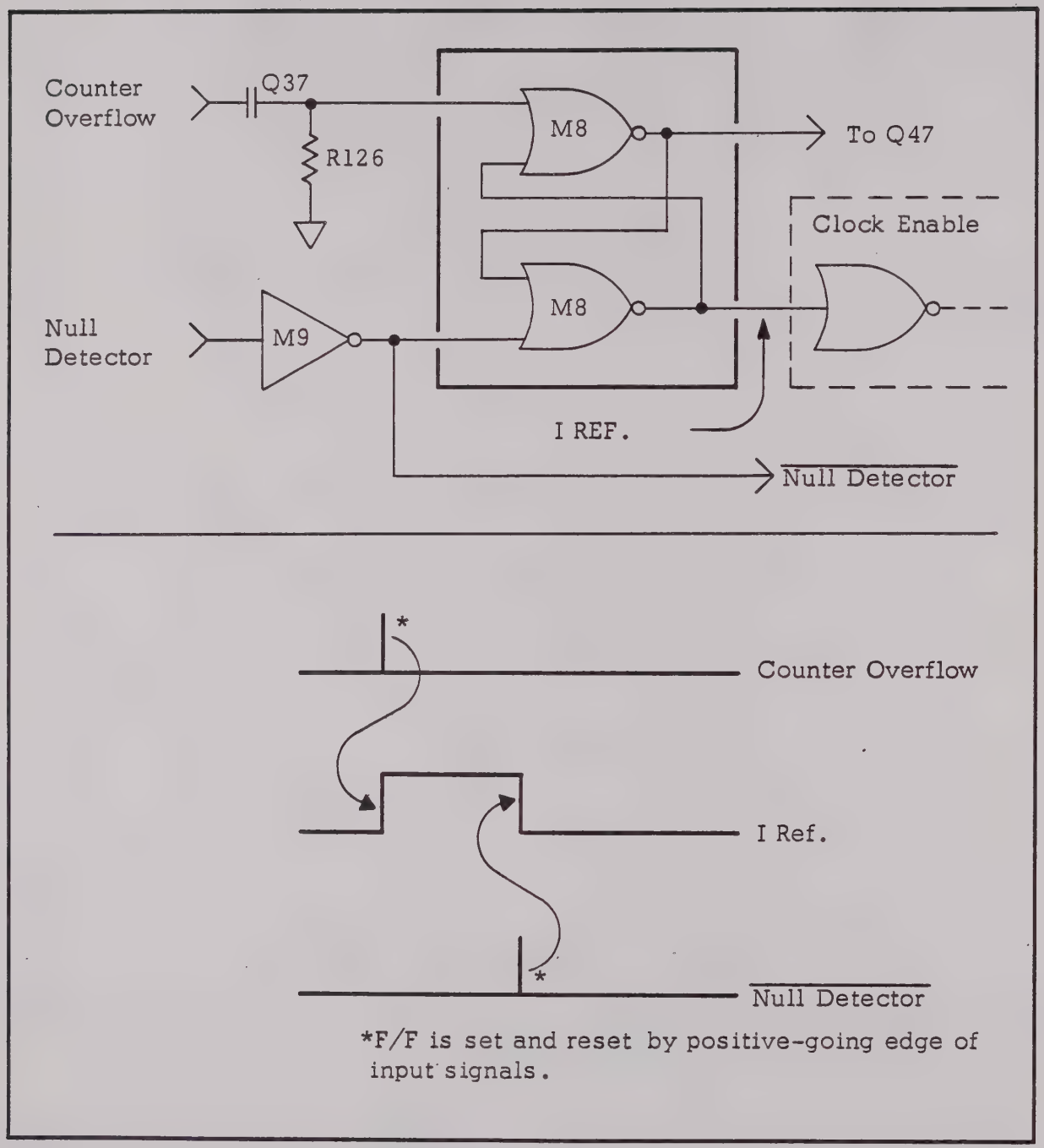


Figure 4.21 - I Reference f/f

4.51 RATE GENERATOR

4.52 The rate generator is a unijunction oscillator, consisting of Q37, and is synchronized to the line frequency by the shaper output through C29. The rate generator produces a pulse approximately five times a second and drives the reset oneshot.

4.53 RESET ONESHOT

4.54 The reset oneshot (shown in figure 4.19) is driven by the rate generator and consists of Nor gate M10 and transistor Q35. The oneshot produces two outputs; the $\overline{\text{Reset}}$ is a positive 18 microsecond pulse and resets the counter to

1000 for the start of a measurement cycle; the Reset is the reciprocal of the reset pulse (output is normally +4 volts going to zero for 18 microseconds during the reset pulse) and drives the I Signal flip flop f/f.

4.55 I SIGNAL F/F

4.56 The I Signal f/f output is set true by $\overline{\text{Reset}}$ and reset (false) by the counter overflow. The I Signal enables the signal current gate on the A to D converter section and provides one of the inputs for the clock enable circuit on the D/D section. The I Signal f/f consists of two nor gates M10-M10 and is shown in figure 4.20.

4.57 REFERENCE F/F

4.58 The I Reference flip-flop (shown in figure 4.21) consists of two nor gates M8-M8. The I Reference output is set true by the counter overflow and reset false by null detector from inverter M9. The I Reference flip-flop is true during the reference integration period (T1-T2) and provides the second input to the clock enable circuit.

4.59 CLOCK ENABLE

4.60 The clock enable circuitry shown in figure 4.22 turns the clock oscillator on and off and consists of nor gate M10-M8, inverter M9 and

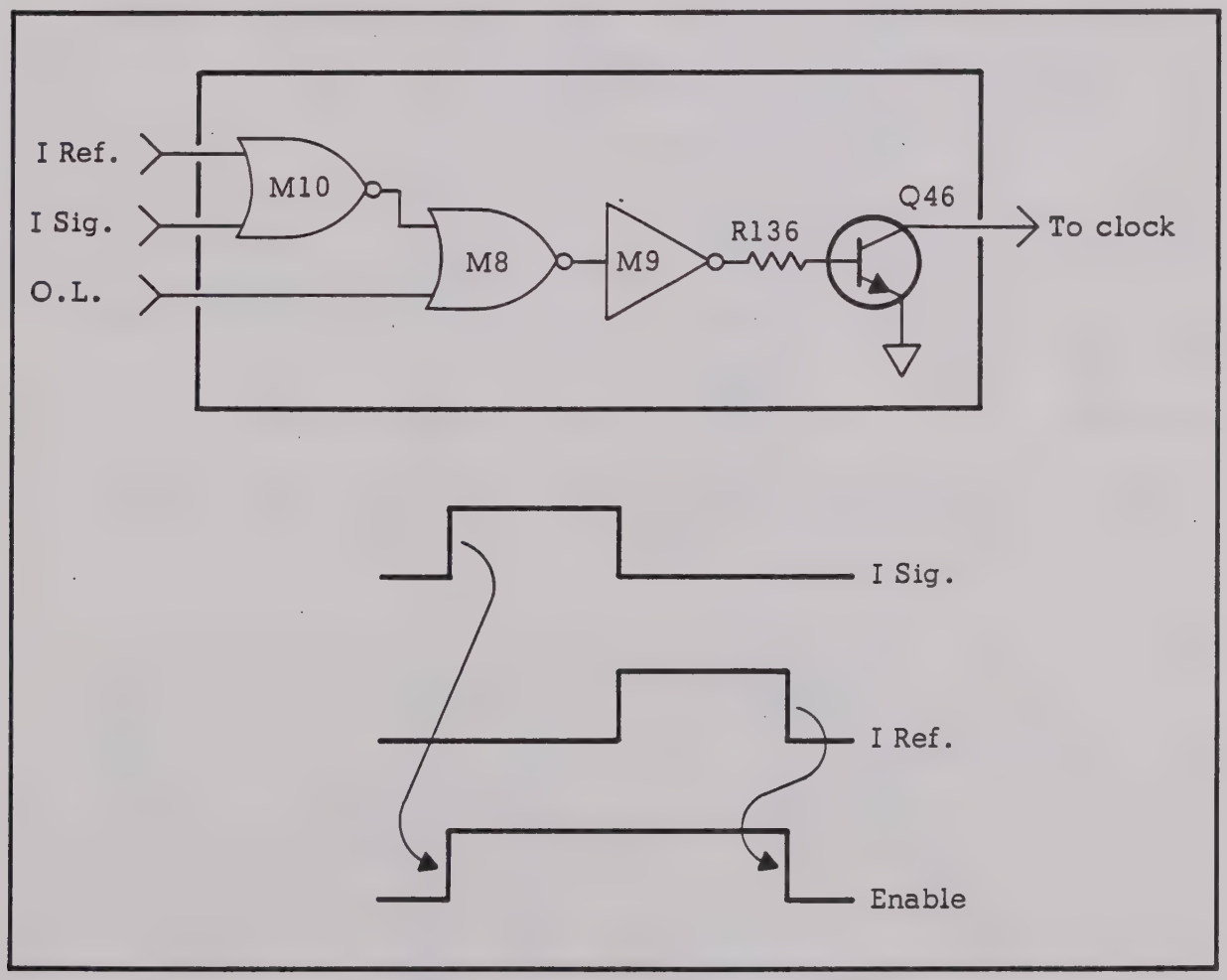


Figure 4.22 - Clock Enable Circuit

transistor Q46. I Signal input is true during the signal integration period and I Reference input is true during the reference integration period. These two inputs hold the output of M10 false during the measurement period (T0-T2). The output of M10 and the output of the overload circuit are fed to nor gate M8. For normal measurements overload is false. During the measurement cycle therefore, the two inputs to M8 are false, making the M8 output true for this same period. The M8 output is inverted and applied, through resistor R136 to the base of Q46. Q46 therefore is off during the measurement cycle and on during the display cycle.

4.61 CLOCK

4.62 The clock is a free running multi-vibrator circuit consisting of transistors Q48 and Q49. The biasing for the base of Q48 is provided by resistors R139 and R140 connected in series. The junction of the two resistors is connected to the collector of Q46. During the display cycle, Q46 is on, holding Q48 off and the clock does not operate. At the start of the measurement cycle, Q46 is turned off allowing Q48 to begin conducting. This allows the clock to be started in the same direction at the beginning of each measurement cycle. The clock output is fed directly to the counter.

4.63 COUNTER

4.64 The counter is a standard 3 decade counter consisting of M2, M4 and M6 and flip-flop M7. The output of the 8 bit of M6 is inverted by inverter M9 and drives M7 which provides the overrange bit. The decades generate an inverted logic 1-2-4-8 output which in turn drives three, BCD to 10-line converters. The counter counts the number of cycles generated by the clock. The three decades are reset to zero by the reset pulse; the overrange f/f is reset true (1) by the reset pulse.

4.65 BCD TO 10-LINE CONVERTERS

4.66 The BCD converters consisting of M1, M3 and M5 convert the BCD data from the decade counters and drive the readout tubes.

4.67 OVERLOAD

4.68 The overload circuit consisting of Nor gate M8 monitors the output of the overrange f/f and the 2 bit of counter M6. When both these lines are false, indicating a count of 1200, the output of M8 goes true enabling overload driver Q45 to conduct and inhibiting the counter. The overload output (as shown in figure 4.23) is also connected to the output of inverter M9. M9 conducts during the I Signal period and prevents the overload from going true during the 1000 to overflow period.

4.69 POLARITY DISPLAY

4.70 The polarity display consists of inverter M9

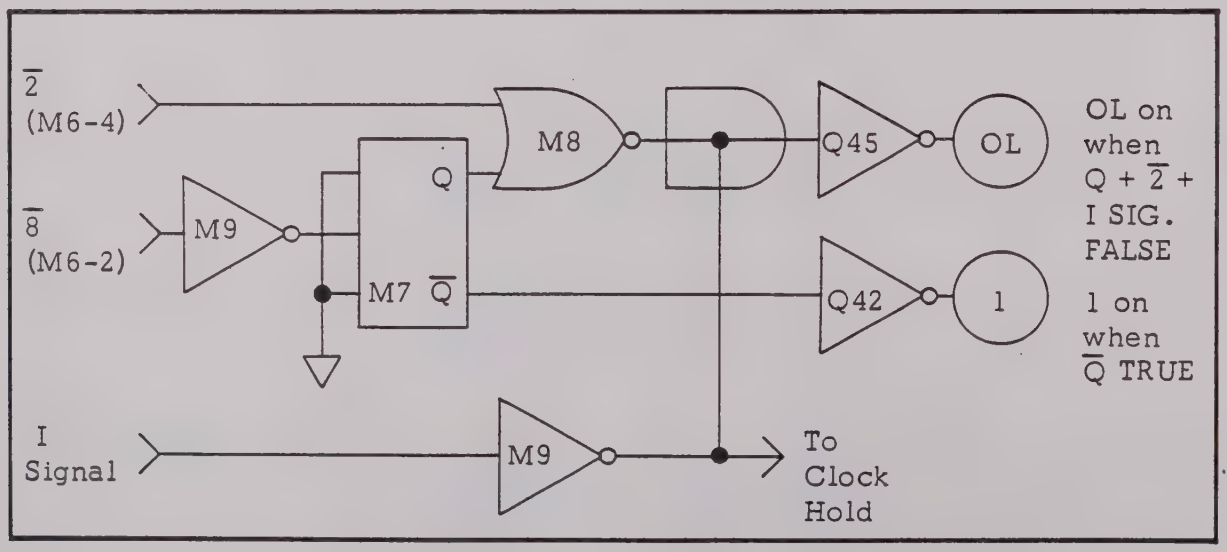


Figure 4.23 - Overload/Overrange Circuit

and drivers Q43 and Q44. The inverter and Q44 are driven by the polarity detector circuit of the A to D converter section. Q43 is driven by the output of the inverter. Both polarity drivers are inhibited by diodes CR33 and CR34 when the NO polarity line is false. (No polarity is false on the AC and Ohms functions.)

4.71 Q47

4.72 The circuit prevents the I Reference f/f from firing during the reset pulse and immediately following the measurement cycle.

4.73 POWER SUPPLY

4.74 The power supply figure 4.24 provides the operating voltage levels for the entire DMM. The +200 supply supplies an unfiltered half-wave voltage to the display tubes. The +4 volt output supplies the operating voltage for all of the integrated circuitry and consists of transistors Q33 and Q34. A full wave rectified and filtered +7 volts is regulated by the two transistors. The regulation is provided by a resistor divided reference from the +20 volt supply. The +20 volt supply is series regulated by transistors Q36, Q37 and zener CR31. The supply is current protected by Q38. The -20 volt supply is series regulated by Q39, Q40 and zener CR32. The -20 volt supply is current protected by transistor Q41.

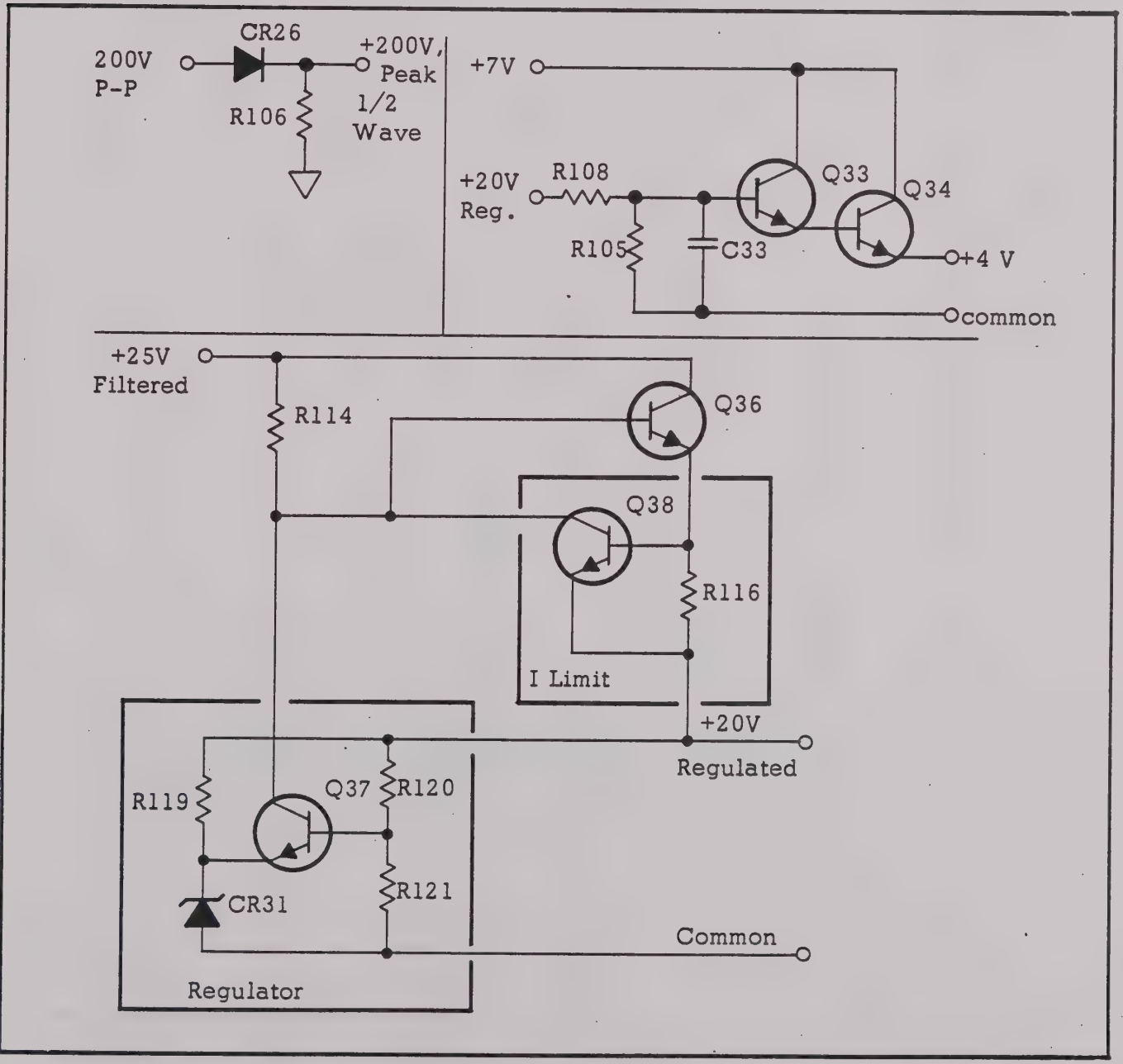
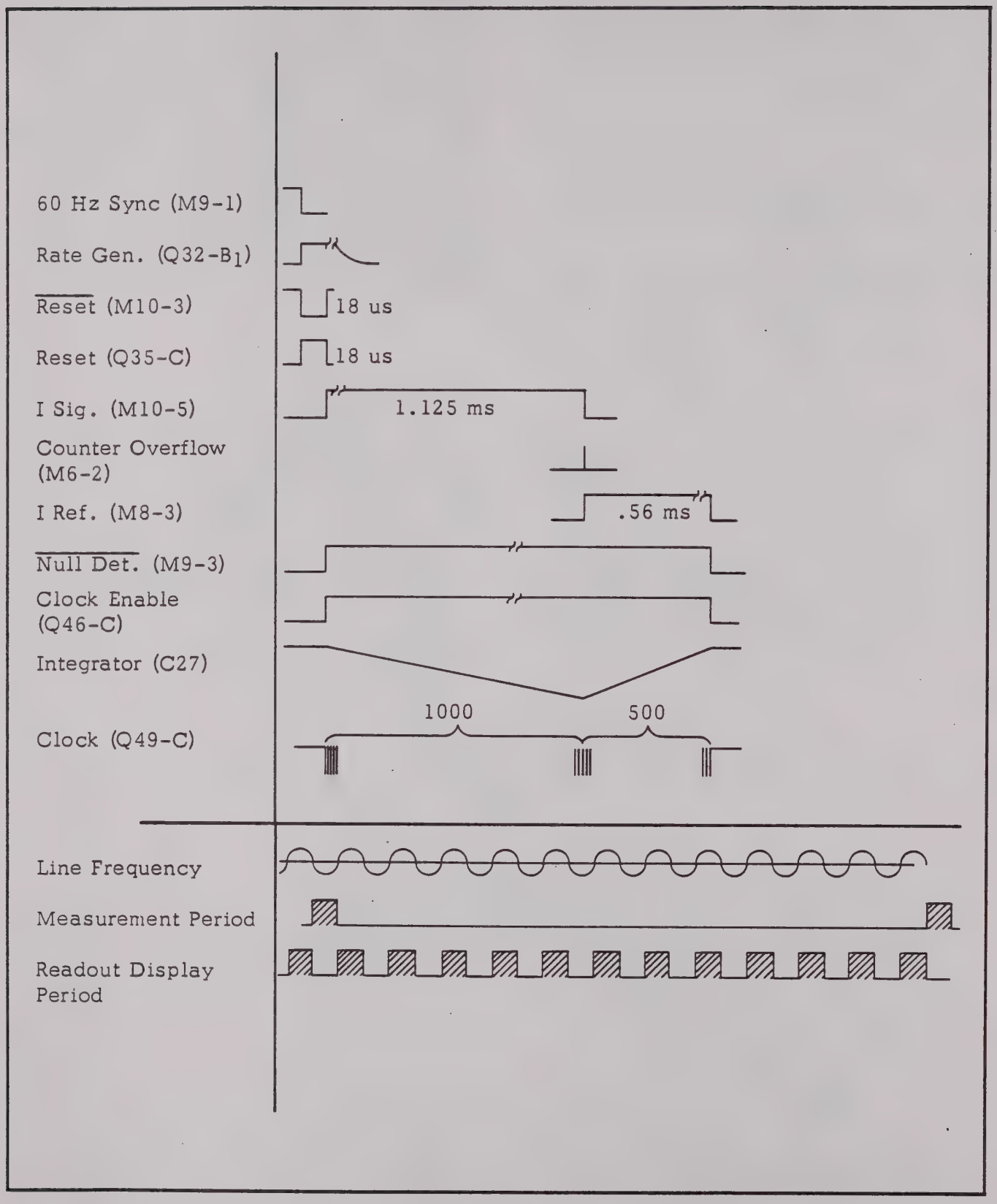


Figure 4.24 - Power Supply

Table 4.3 - Timing Diagram (0.5 volts in)



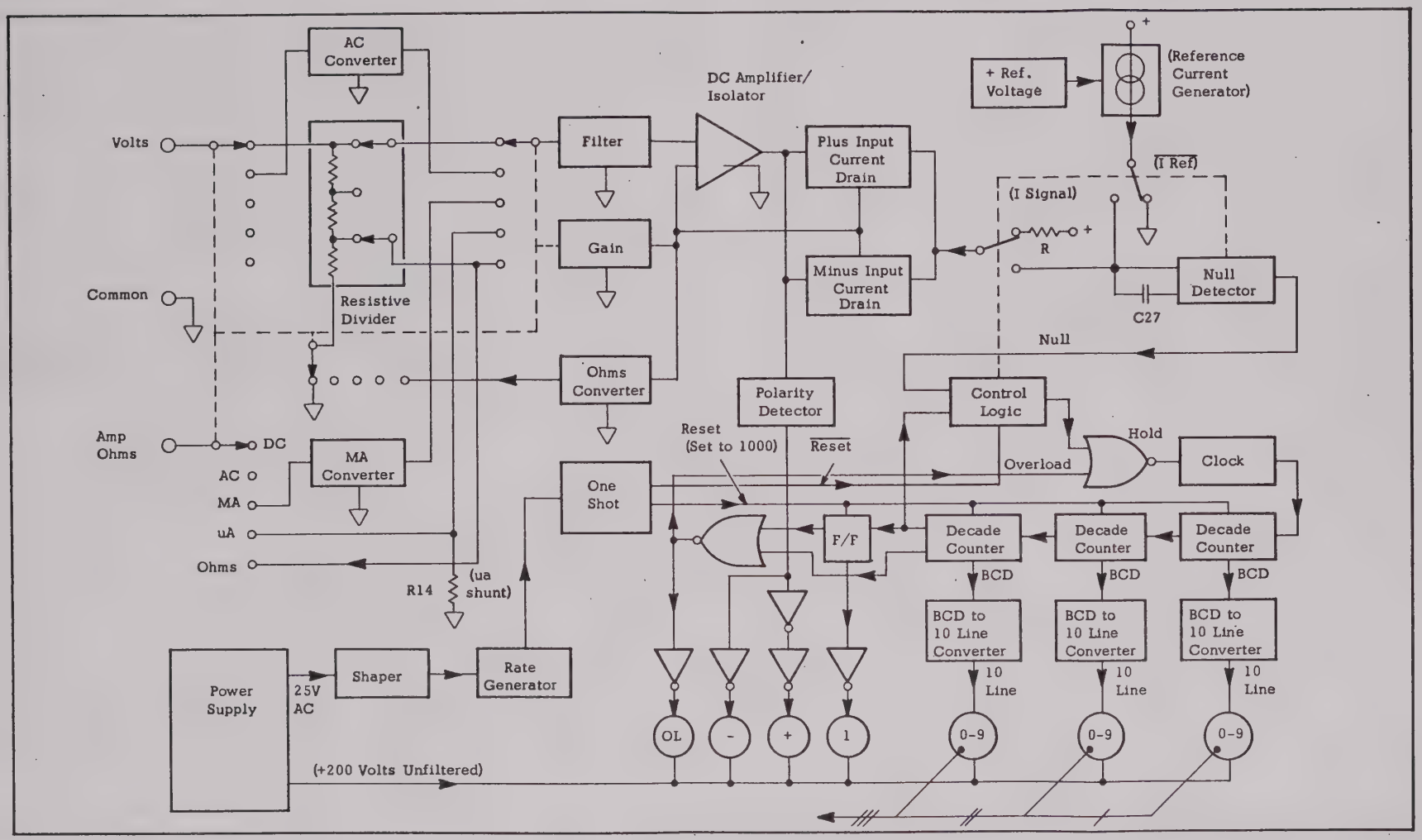


*Figure 4.25 - Model 3800 DMM - **Block Diagram***

SECTION 5

CALIBRATION

5.1 INTRODUCTION

5.2 This calibration procedure is designed to assure the 3800 DMM operates within its specifications. Any necessary maintenance should be done prior to calibration. The calibration steps in this procedure rely on the adjusted accuracy of the preceding step, therefore care must be taken to make each adjustment in the order that it appears in this procedure.

5.3 EQUIPMENT REQUIRED

The following equipment, or an acceptable equivalent, is required for DMM calibration and is listed in order of use. The test equipment specifications listed are used and recommended by DANA for calibration.

I. BASIC DC CALIBRATION OF THE DMM

(a) A precision DC voltage standard variable from 0 to 1000 volts having a resolution of 100 microvolts at 10 volts and an accuracy of .003%. For example, the COHU MODEL 351.

(b) A precision decade divider having an input resistance of 10 Kohms and an output resistance of 5 Kohms maximum, and an accuracy of .005%. For example, the ESI MODEL RV622A.

II. AC CALIBRATION OF THE DMM

(a) An AC laboratory power source, variable from 0 to 500 volts RMS and 50 Hz to 100 kHz, having a resolution better than 100 PPM, harmonic distortion of .1%. For example, the OPTIMATION type AC 104 (oscillator, matching transformer, and power amplifier).

(b) An AC/DC laboratory transfer standard (for calibration of the AC source) having an accuracy of .05%. For example, the HOLT MODEL 6 thermal transfer voltmeter.

III. MILLIAMPS AND MICROAMPS CALIBRATION OF THE DMM

(a) A power supply with the capability of delivering 1000 mA in the current mode. For example, the SORRENSON QRB 30-1.

(b) A current shunt resistor capable of 1 amp to standardize the current source. For example, 10 volts across 10 ohms.

IV. OHMS CALIBRATION OF THE DMM

(a) Standard resistors: 100 ohms, 1 Kohm, 100 Kohm, and 1 Mohm with a value known to .005% and a 10 Mohm with a value known to .01%. For example the ESI SR-1 series standard resistors.

V. TOOLS REQUIRED FOR CALIBRATION

(a) An insulated blade type calibration tool.

(b) A No. 1 Phillips screwdriver.

VI. PREPARATION FOR CALIBRATION

(a) Remove the four screws on the back panel of the DMM and slide the panel out of the strain relief pushing on the AC power cord. Slide the DMM circuit board through the front of the case to expose the adjustments.

(b) Set the DMM controls as follows:

Function:	Volts DC
Range:	10
Input:	Shorted (Red to black)

(c) Set the ON-OFF switch to the ON position and allow 30 minutes for warmup.

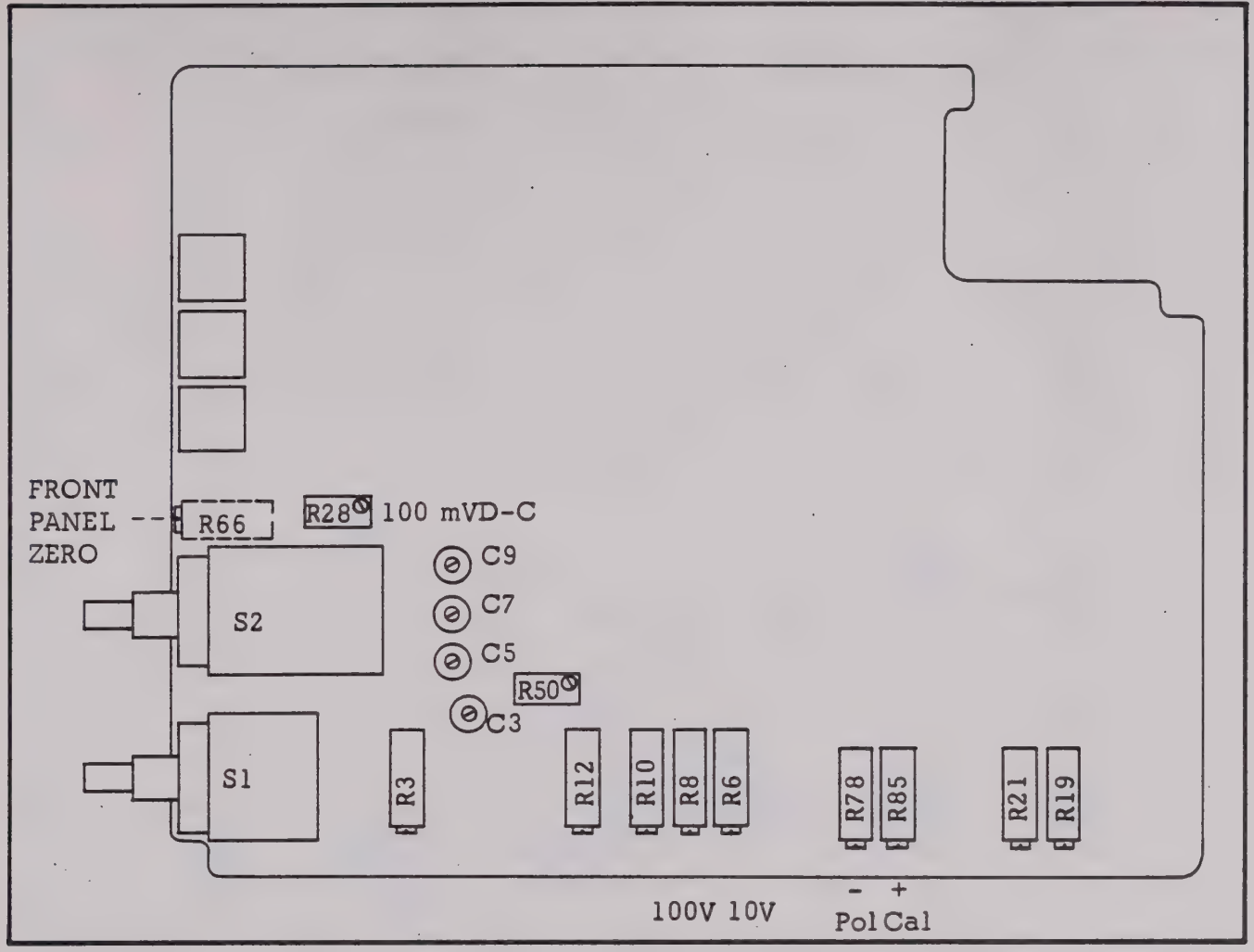


Table 5.1 - DC Calibration

FUNCTION	RANGE	INPUT	ADJUST	DISPLAY	REMARKS
VDC	100 mVDC	0V	R66	00.0	Polarity Indicators flashing
VDC	1 VDC	+1.190	R85	+1.190	Plus full scale adjust
VDC	1 VDC	-1.190	R78	-1.190	Minus full scale adjust
VDC	100 mVDC	+119.0mV	R28	+119.0mV	Millivolts full scale adjust
VDC	100 mVDC	-119.0mV	-	-119.0mV	± 1 digit
VDC	10 VDC	+11.90V	R6	+11.90V	10 volt full scale adjust
VDC	10 VDC	-11.90V		-11.90V	10 volt full scale adjust
VDC	100 VDC	+119.0V	R8	+119.0V	100 volt full scale adjust
VDC	100 VDC	-119.0V		-119.0V	100 volt full scale adjust

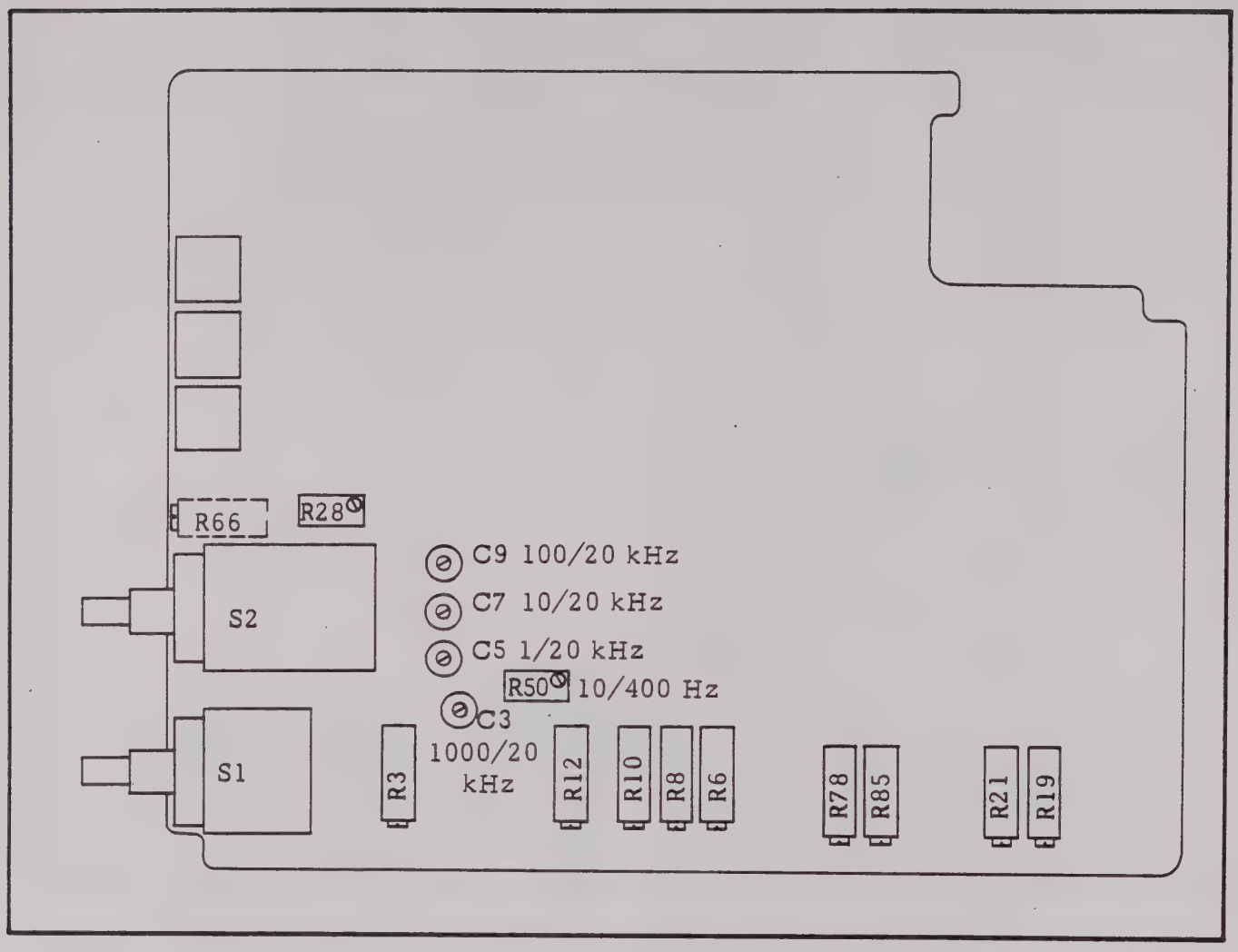


Table 5.2 - AC Calibration

FUNCTION	RANGE	INPUT	ADJUST	DISPLAY	REMARKS
VAC	10 VAC	11.90VRMS	R50	11.90VRMS	@ 400 Hz
VAC	1000 VAC	500.0VRMS	C3	500.0VRMS	± 5 digits @ 20 kHz
VAC	1 VAC	1.190VRMS	C5	1.190VRMS	± 5 digits @ 20 kHz
VAC	10 VAC	11.90VRMS	C7	11.90VRMS	± 5 digits @ 20 kHz
VAC	100 VAC	119.0VRMS	C9	119.0VRMS	± 5 digits @ 20 kHz (If C9 does not have enough adjustment, "FSV Capacitor", C10, will have to be padded

CAUTION

When changing frequency of the AC Generator, decrease the output voltage. This will prevent switching transients (up to 1000 v.) from damaging the DVM input circuitry.

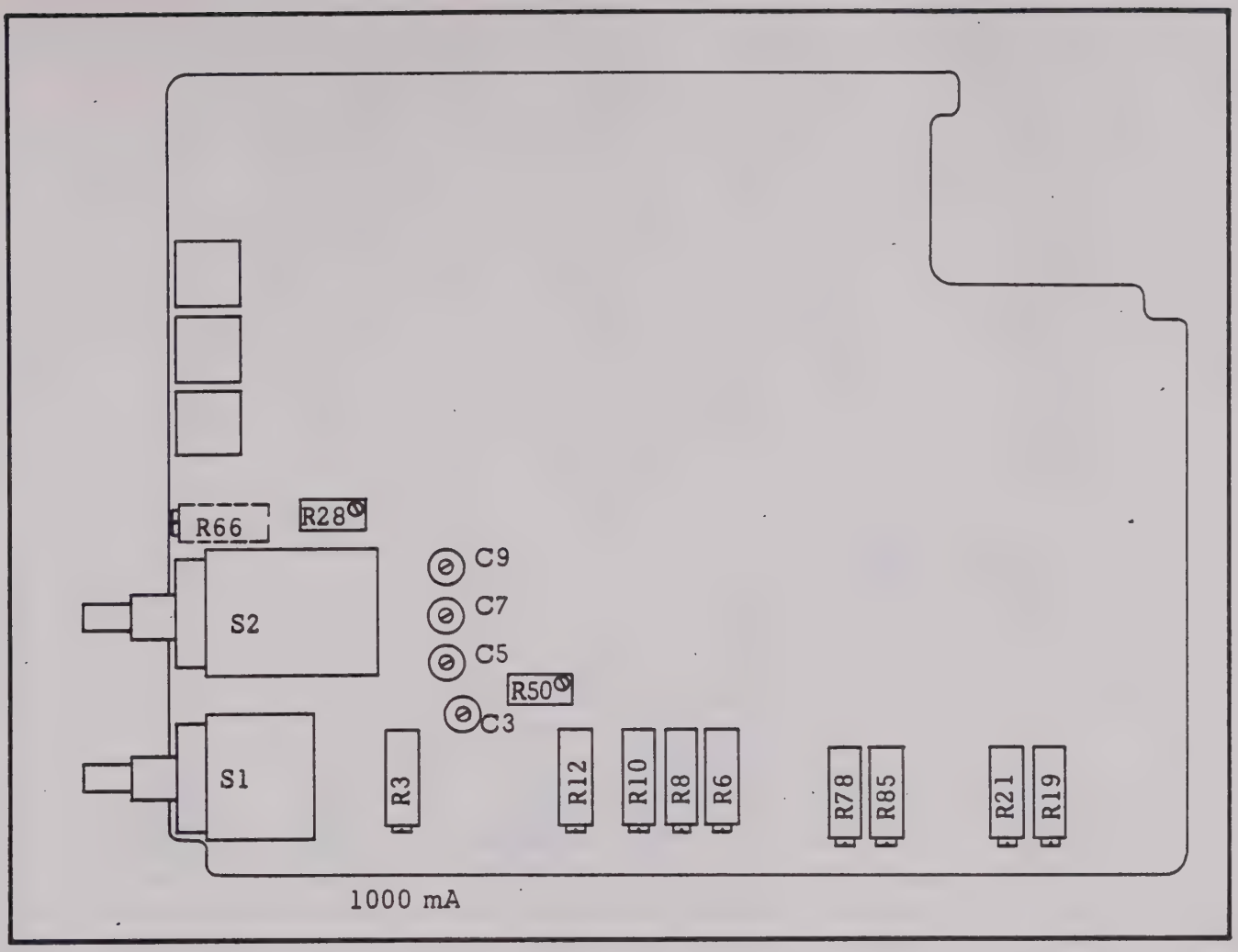


Table 5.3 - Current Calibration

FUNCTION	RANGE	INPUT	ADJUST	DISPLAY	REMARKS
MADC	1000 mADC	+1190 mA	R3	+1190 mADC	Milliamp full scale adjus
MADC	1000 mADC	-1190 mA	-	-1190 mADC	± 2 digits
MADC	100 mADC	+100.0 mA	-	+100.0 mADC	± 2 digits
MADC	100 mADC	-100.0 mA	-	-100.0 mADC	± 2 digits
MADC	10 mADC	+10.00 mA	-	+10.00 mADC	± 2 digits
MADC	10 mADC	-10.00 mA	-	-10.00 mADC	± 2 digits
MADC	1 mADC	+1.000 mA	-	+1.000 mADC	± 2 digits
MADC	1 mADC	-1.000 mA	-	-1.000 mADC	± 2 digits
uADC	100 uADC	+100.0 uA	-	+100.0 uADC	± 2 digits
uADC	100 uADC	-100.0 uA	-	-100.0 uADC	± 2 digits
uADC	10 uADC	+10.00 uA	-	+10.00 uADC	± 2 digits
uADC	10 uADC	-10.00 uA	-	-10.00 uADC	± 2 digits

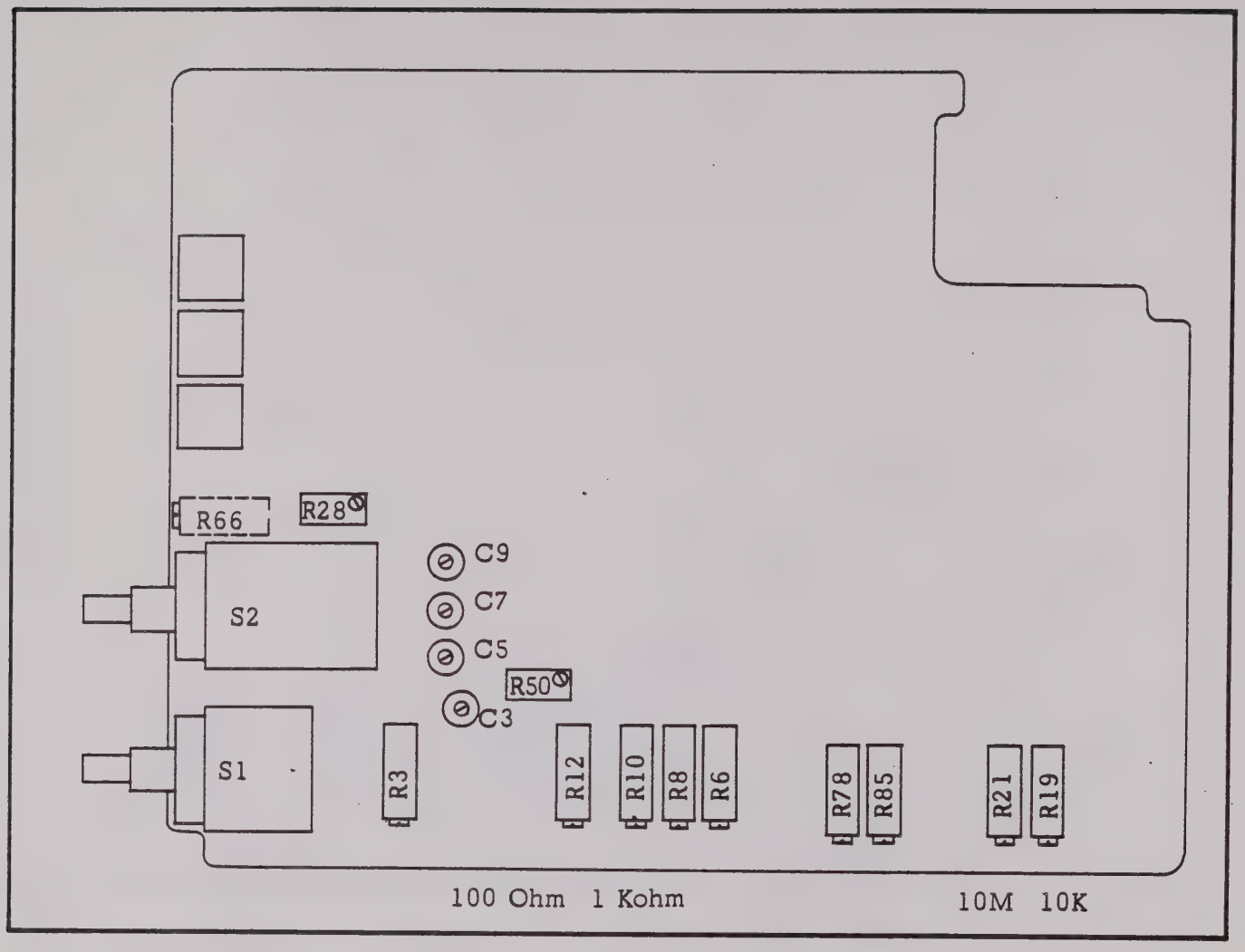


Table 5.4 - Resistance Calibration

FUNCTION	RANGE	INPUT	ADJUST	DISPLAY	REMARKS
Ohms	10 Kohm	10 Kohm	R19	10.00	± 1 Digit
Ohms	10 Mohm	10 Mohm	R21	10.00	± 1 digit
Ohms	1 Kohm	1 Kohm	R10	1.000	± 1 digit
Ohms	100 Ohm	100 Ohm	R12	100.0*	± 1 digit *(Short input leads, note digits off-set, and adjust the display for the standard plus the offset)
Ohms	1000 Kohm	1 Mohm	-	1000	± 1 digit
Ohms	100 Kohm	100 Kohm	-	100.0	± 1 digit

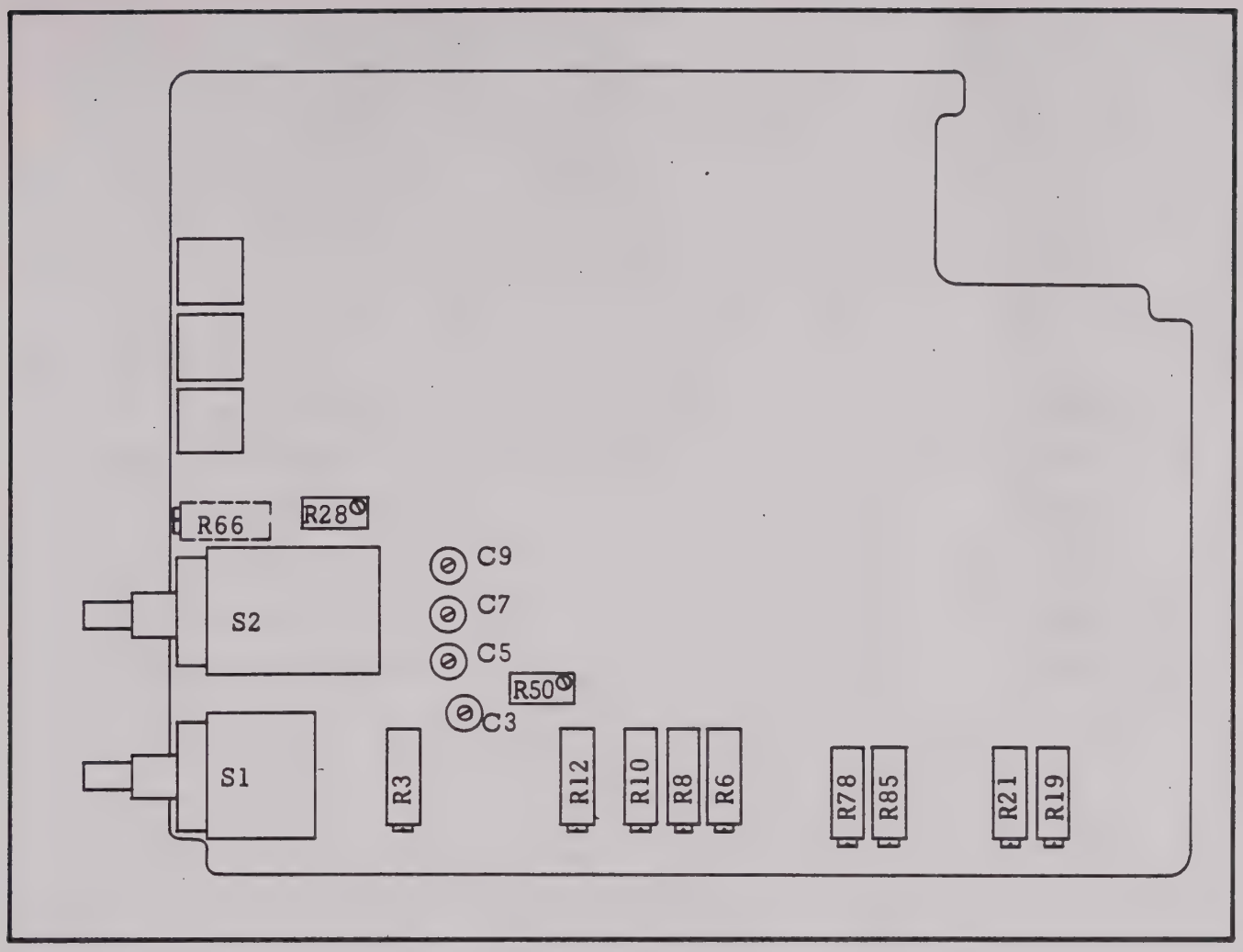


Table 5.5 - 1000 Volt Range Check

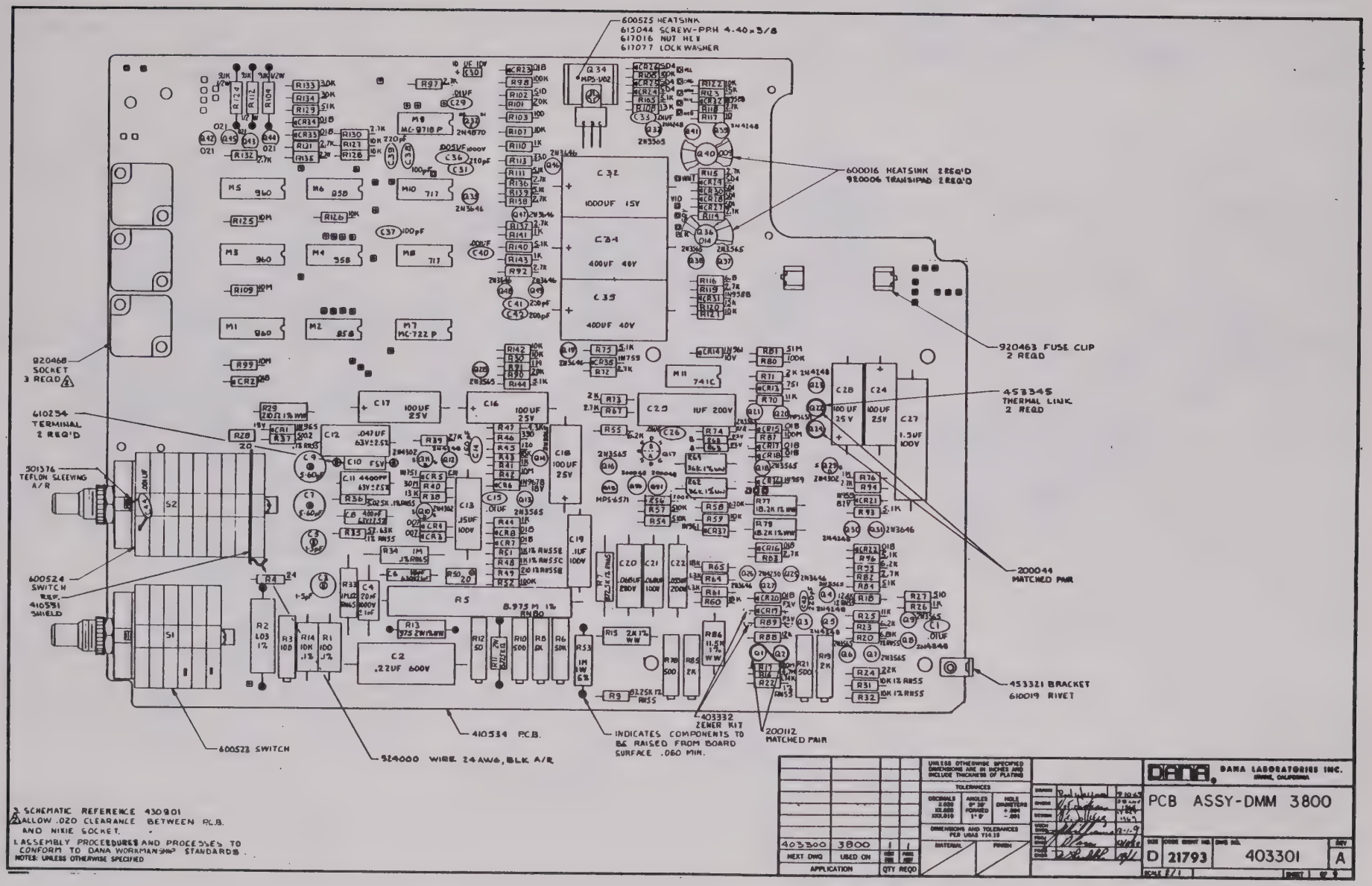
FUNCTION	RANGE	INPUT	ADJUST	DISPLAY	REMARKS
VDC	1000	+1000	-	+1000	± 4 digits
VDC	1000	-1000	-	-1000	± 4 digits

SECTION 6

DRAWINGS

6.1 DRAWINGS

PCB Assembly - DMM 3800	403301
Schematic DMM 3800	430901
Module Assembly DMM 3800E	403336
PCB Assembly Output Option 1	403337
Schematic Output Option 1	403914
Assembly Hooded Connection	403338



⚠3 SCHEMATIC REFERENCE 430901
⚠ALLOW .020 CLEARANCE BETWEEN P.C.B. AND NIXIE SOCKET.
4. ASSEMBLY PROCEDURES AND PROCESSES TO CONFORM TO DANA WORKMANSHIP STANDARDS.
NOTES: UNLESS OTHERWISE SPECIFIED

403300	3800	1	1
NEXT DWG	USED ON		
APPLICATION		QTY REQD	

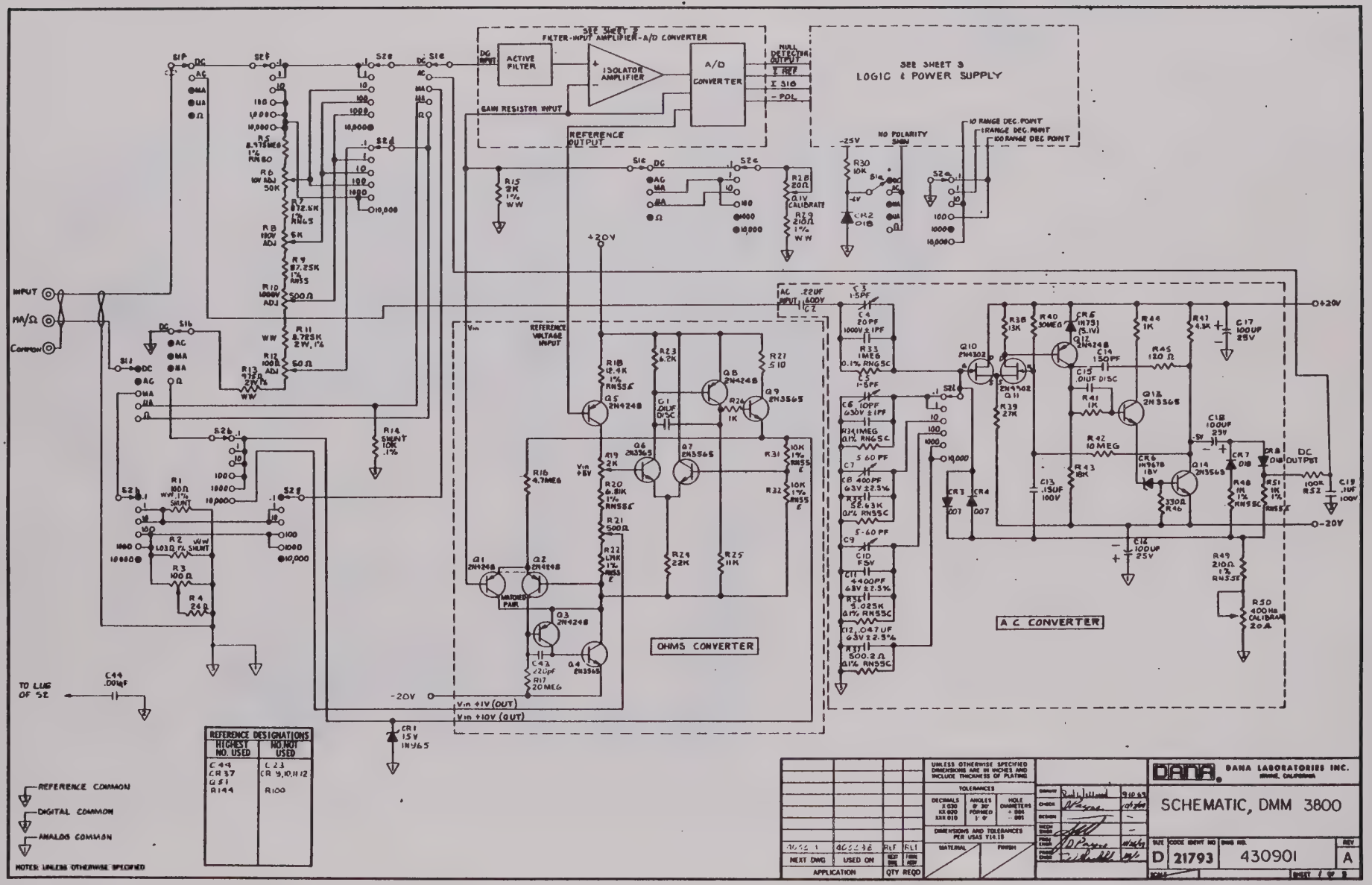
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING
TOLERANCES
DECIMALS .XXX ±.005 .XXX ±.010
ANGLES 0° 30' FORMED 1°0
HOLE DIAMETERS ±.004 -.001
DIMENSIONS AND TOLERANCES PER ANSI Y14.5M
MATERIAL
FINISH

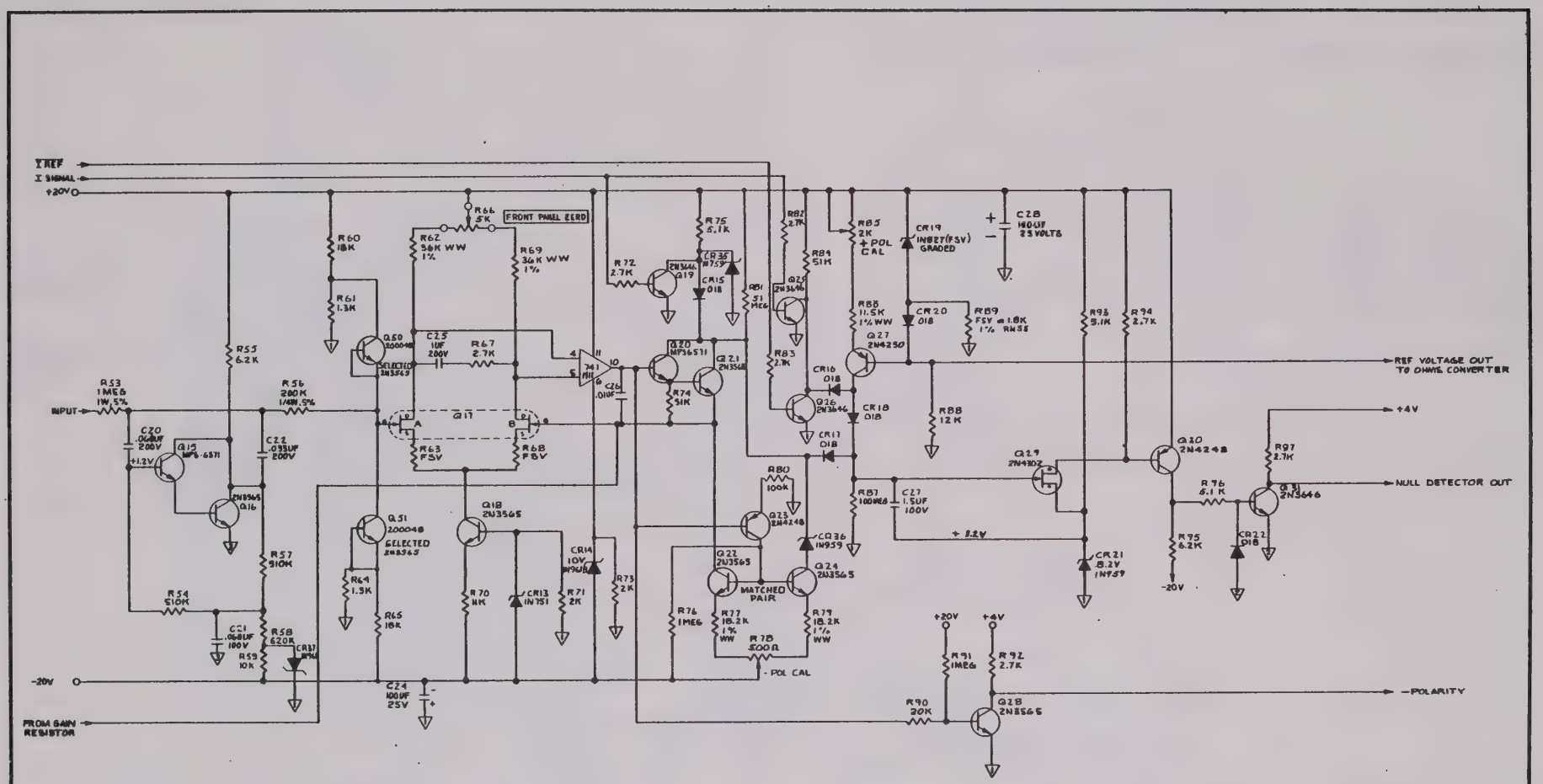
DANA LABORATORIES INC. IRVINE, CALIFORNIA

PCB ASSY-DMM 3800

SIZE	CODE IDENT NO.	DWG NO.	REV
D	21793	403301	A

SCALE 8/1 SHEET 1 OF 3


SEE SHEET 2
FILTER-INPUT AMPLIFIER-A/D CONVERTER
ACTIVE FILTER
ISOLATOR AMPLIFIER
A/D CONVERTER
SEE SHEET 3
LOGIC & POWER SUPPLY
REFERENCE OUTPUT
GAIN RESISTOR INPUT
NULL DETECTOR OUTPUT
+I REF
-I SIG
-POL
INPUT
MA/Ω
Common
+20V
-20V
OHMS CONVERTER
A C CONVERTER
DC OUTPUT
TO LUG OF S2
Vin +1V (OUT)
Vin +10V (OUT)
MATCHED PAIR
REFERENCE DESIGNATIONS
HIGHEST NO. USED
NO NOT USED
C44
CR37
Q51
R144
C23
CR 9,10,11,12
R100
REFERENCE COMMON
DIGITAL COMMON
ANALOG COMMON
NOTES: UNLESS OTHERWISE SPECIFIED
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING
TOLERANCES
DECIMALS
ANGLES
HOLE DIAMETERS
DIMENSIONS AND TOLERANCES PER USAS Y14.5
MATERIAL
FINISH
NEXT DWG
USED ON
APPLICATION
QTY REQD
DANA LABORATORIES INC.
IRVINE, CALIFORNIA
SCHEMATIC, DMM 3800
SIZE
CODE IDENT NO
21793
DWG NO
430901
REV
A
SCALE
SHEET 1 OF 3



(SEE SHEET ONE)
NOTES: UNLESS OTHERWISE SPECIFIED

403301	403298	REF	REF
NEXT DWG	USED ON	ECO DWG	FSRG ASSY
APPLICATION		QTY REQD	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING

TOLERANCES

DECIMALS	ANGLES	HOLE DIAMETERS
X.020	0° 30'	+.004
XX.010	FORMED	-.001
XXX.010	1° 0'	

DIMENSIONS AND TOLERANCES PER USAS Y14.15

MATERIAL | FINISH

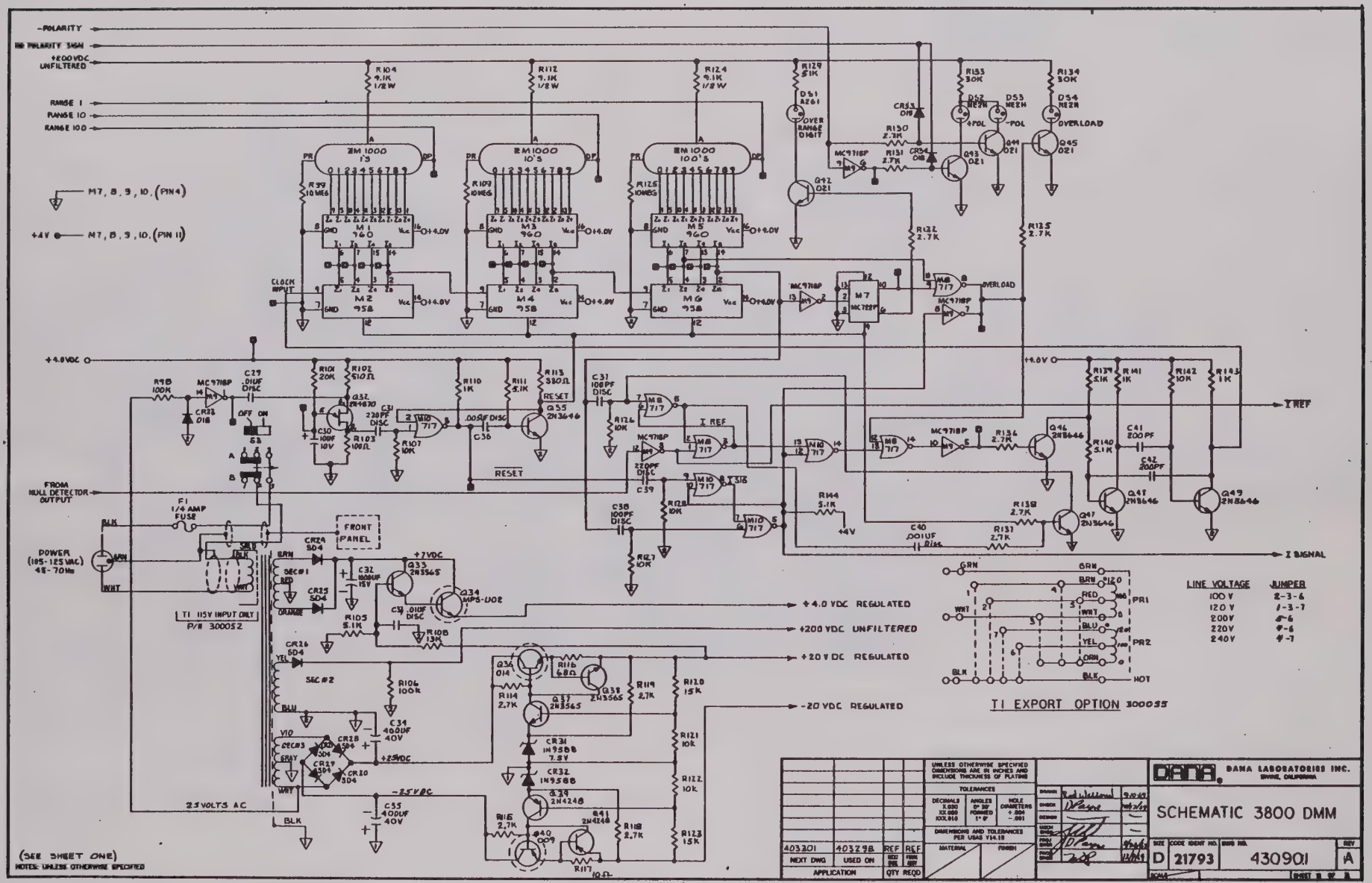
DRAWN 9 10 69
CHECK 10/24/69
DESIGN
ENGR DESIGN
PROJ ENGR 10/24/69
PROD ENGR 10/24/69

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

SCHEMATIC, 3800 DMM

SIZE	CODE IDENT NO.	DWG NO.	REV
D	21793	430901	A

SCALE | SHEET 1 OF 1



403201	403298	REF	REF
NEXT DWG	USED ON	SCH	PWB ASY
APPLICATION		QTY REQD	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING

TOLERANCES

DECIMALS	ANGLES	HOLE DIAMETERS
X.030	0° 30'	+.004
XX.010	FORMED	-.001
XXX.010	1° 0"	

DIMENSIONS AND TOLERANCES PER USAS Y14.5

MATERIAL | FINISH

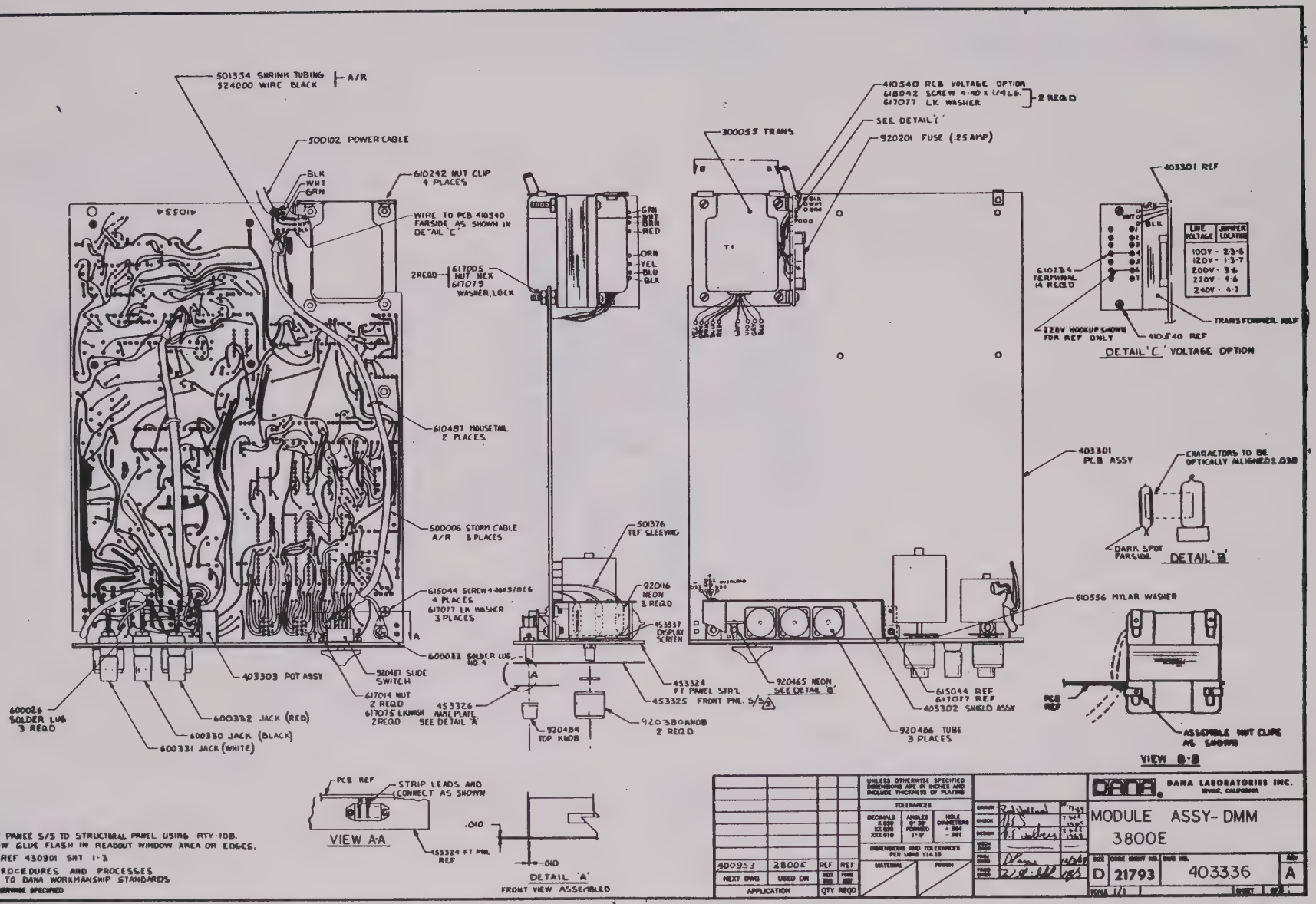
DRAWN 9-10-69
CHECK
ENGR
SCHEM
PROJ ENGR
ENGR APPR
PROJ APPR

DANA LABORATORIES INC. IRVINE, CALIFORNIA

SCHEMATIC 3800 DMM

SIZE	CODE IDENT NO.	DWG NO.	REV
D	21793	430901	A

SCALE | SHEET 1 OF 1



⚠ BOND FRONT PANEL S/S TO STRUCTURAL PANEL USING RTV-108. DO NOT ALLOW GLUE FLASH IN READOUT WINDOW AREA OR EDGES.

SCHEMATIC REF 430901 SHT 1-3

1. ASSEMBLY PROCEDURES AND PROCESSES TO CONFORM TO DANA WORKMANSHIP STANDARDS

REFER: UNLESS OTHERWISE SPECIFIED

400953	3800E	REF DES	REF PART
NEXT DWG	USED ON		
APPLICATION		QTY REQD	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING

TOLERANCES

DECIMALS	ANGLES	HOLE DIAMETERS
X.030	0° 30' FORMED	+ .004
XX.010	1° 0'	- .001
XXX.010		

DIMENSIONS AND TOLERANCES PER USAS Y14.5M

MATERIAL | FINISH

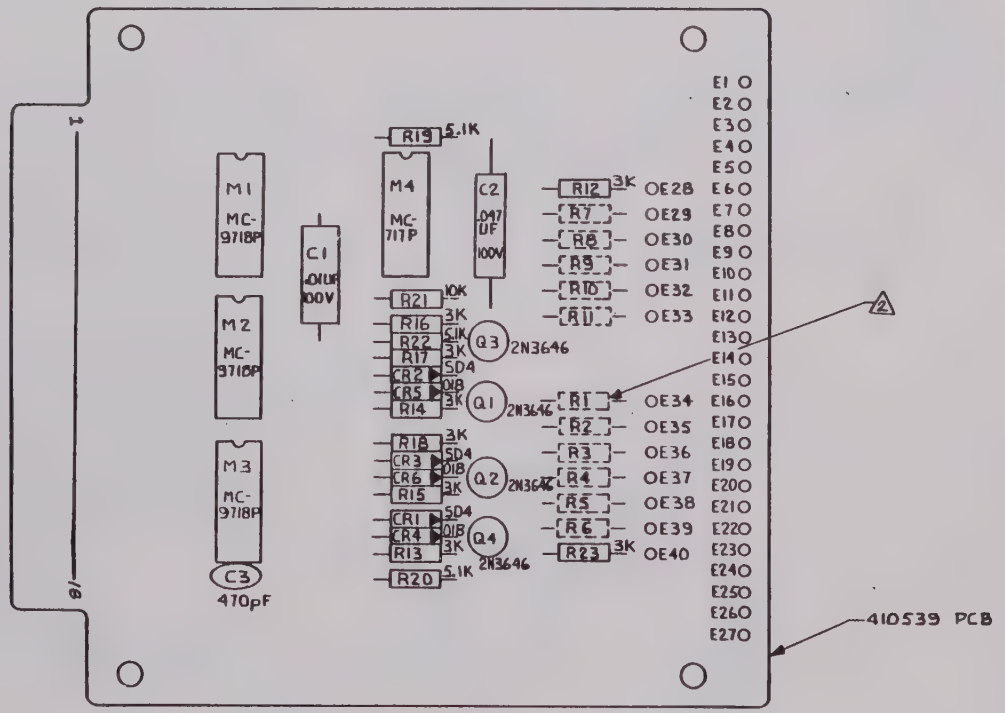
DRAWN | CHECK | DESIGN | WORK ORDER | PROJ. ENGR. | PROD. ENGR.

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

MODULE ASSY- DMM
3800E

SIZE	CODE IDENT NO.	DWG NO.	REV
D	21793	403336	A

FORM 171 | SHEET



⚠2 R1 THRU R11 ARE NOT INSTALLED ON THIS ASSY. CIRCUITRY AND HOLES ARE PROVIDED FOR SPECIAL APPLICATION. SEE SCHEMATIC 403914 FOR INSTRUCTIONS.

1 ASSEMBLY PROCEDURES AND PROCESSES TO CONFORM TO DANA WORKMANSHIP STANDARDS.

NOTES: UNLESS OTHERWISE SPECIFIED

NEXT DWG	USED ON	QTY REQD: NEXT DWG	QTY REQD: FINAL ASSY
400955	3800E OPT 1	1	1
400954	3800 OPT 1	1	1

APPLICATION

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND INCLUDE THICKNESS OF PLATING

TOLERANCES

DECIMALS	ANGLES	HOLE DIAMETERS
X.030	0° 30'	+.004
XX.020	FORMED	-.001
XXX.010	1° 0'	

DIMENSIONS AND TOLERANCES PER USAS Y14.15

MATERIAL / FINISH

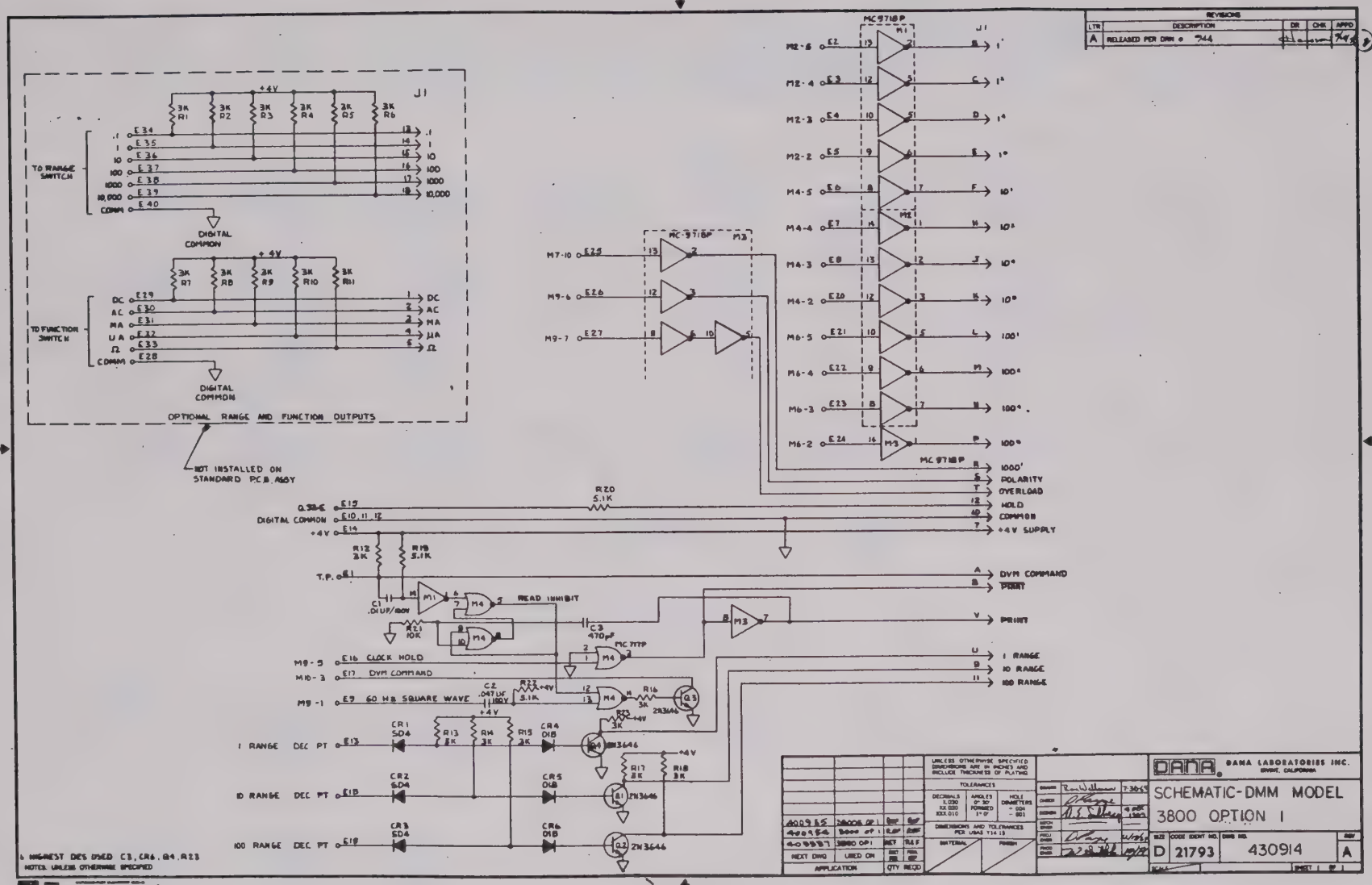
DRAWN	Ron Wellwood	12-3-69
CHECK	W. Salinas	
DESIGN	W.E. Wallberg	4 DEC 1969
MECH ENGR		
PROJ ENGR	D. Wayne	4/4/69
PROD ENGR	R. Gribble	12/19

DANA® DANA LABORATORIES INC. IRVINE, CALIFORNIA

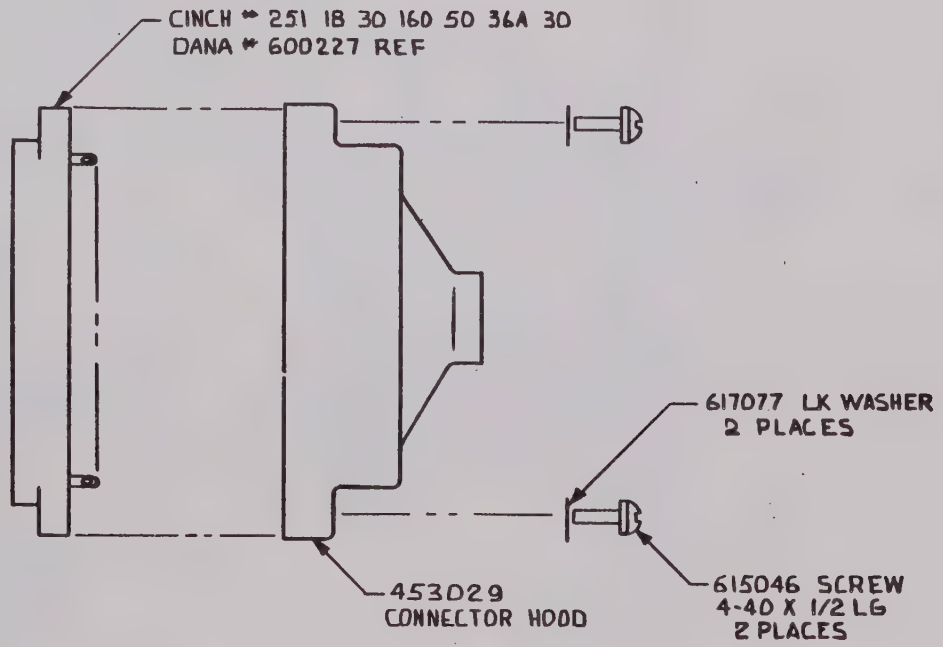
P.C.BOARD ASSY- OUTPUT OPTION 1

SIZE	CODE IDENT NO.	DWG NO.	REV
C	21793	403337	A

SCALE 2/1 SHEET 1 OF 2


REVISIONS
LTR DESCRIPTION DR CHK APPD
A RELEASED PER DRN # 744
J1
+4V
3K R1
3K R2
3K R3
3K R4
3K R5
3K R6
TO RANGE SWITCH
.1 E34
1 E35
10 E36
100 E37
1000 E38
10,000 E39
COMM E40
DIGITAL COMMON
3K R7
3K R8
3K R9
3K R10
3K R11
TO FUNCTION SWITCH
DC E29
AC E30
MA E31
μA E32
Ω E33
COMM E28
DIGITAL COMMON
OPTIONAL RANGE AND FUNCTION OUTPUTS
NOT INSTALLED ON STANDARD P.C.B. ASSY
MC 9718P
M1
M2
M3
M2-6 E2
M2-4 E3
M2-3 E4
M2-2 E5
M4-5 E6
M4-4 E7
M4-3 E8
M4-2 E20
M6-5 E21
M6-4 E22
M6-3 E23
M6-2 E24
M7-10 E25
M9-6 E26
M9-7 E27
J1
1'
1"
1³
1⁴
10'
10²
10³
10⁴
100'
100"
100³
100⁴
1000'
POLARITY
OVERLOAD
HOLD
COMMON
+4V SUPPLY
R20 5.1K
Q.38-E E19
DIGITAL COMMON E10,11,12
+4V E14
R12 3K
R19 5.1K
T.P. E1
C1 .01 UP/DOWN
R21 10K
READ INHIBIT
C3 470pF
MC 7TTP
M8-5 E16 CLOCK HOLD
M10-3 E17 DVM COMMAND
M8-1 E7 60 HZ SQUARE WAVE
C2 .047 UF 100V
R22 5.1K
R16 3K
Q3 2N3646
R23 3K
DVM COMMAND
PRINT
1 RANGE
10 RANGE
100 RANGE
1 RANGE DEC PT E13
10 RANGE DEC PT E18
100 RANGE DEC PT E18
CR1 SD4
CR2 SD4
CR3 SD4
CR4 D1B
CR5 D1B
CR6 D1B
R13 3K
R14 3K
R15 3K
R17 3K
R18 3K
Q1 2N3646
Q2 2N3646
6 HIGHEST DIES USED C3, CR6, Q4, R23
NOTES: UNLESS OTHERWISE SPECIFIED
DANA DANA LABORATORIES INC. IRVINE, CALIFORNIA
SCHEMATIC-DMM MODEL 3800 OPTION 1
SIZE D
CODE IDENT NO. 21793
DWG NO. 430914
REV A
SHEET 1 OF 1

REVISIONS			
LTR	DESCRIPTION	DATE	APPROVED
A	REL. PER DRN. NO. 944	12-24-9	Hanaster



NEXT DWG	USED ON	NEXT DWG	FINAL ASSY
400957	38600P1	1	1
400959	3800 OPT. 1	1	1
APPLICATION		QTY REQD	

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON:
DECIMALS .X .030 .XX .020 .XXX .010 | ANGLES 0° 30' FORMED 1° 0' | HOLE DIAMETERS +.004 −.001

MATERIAL

FINISH

DRAWN	R. Wellman	11-22-69
CHECK	W. Sullivan	11 Dec 1969
DESIGN	R. Wellman	11-22-69
MECH ENGR		
PROJ ENGR	[illegible]	2/4/70
	W. Stubble	12/3/70

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

HOODED CONNECTOR ASSY.

SIZE	CODE IDENT NO.	DWG NO.	REV
B	21793	403338	A

SCALE 1/1 SHEET 1 OF 2

⚠ ASSEMBLY PROCEDURES AND PROCESSES TO CONFORM TO DANA WORKMANSHIP STANDARDS.

NOTES: UNLESS OTHERWISE SPECIFIED

PARTS LIST

ASSEMBLY 403301 DMM MODEL 3800 A

REF. DESIG.	PART NO.	DESCRIPTION	
CR01	220022	DIODE SILICO ZENER 1N965B	MOTOROLA 1N965B
CR02	211083	DIODE SILICO 018	DANA 211083
CR03	211236	DIODE SILICO 007	DANA 211236
CR04	211236	DIODE SILICO 007	DANA 211236
CR05	220007	DIODE SILICO ZENER 1N751	MOTOROLA 1N751
CR06	220015	DIODE SILICO ZENER 1N967B	MOTOROLA 1N967B
CR07	211083	DIODE SILICO 018	DANA 211083
CR08	211083	DIODE SILICO 018	DANA 211083
CR13	220007	DIODE SILICO ZENER 1N751	MOTOROLA 1N751
CR14	220004	DIODE SILICO ZENER 1N961B	MOTOROLA 1N961B
CR15	211083	DIODE SILICO 018	DANA 211083
CR16	211083	DIODE SILICO 018	DANA 211083
CR17	211083	DIODE SILICO 018	DANA 211083
CR18	211083	DIODE SILICO 018	DANA 211083
CR19	220044	DIODE SILICO ZENER 1N821	
CR20	211083	DIODE SILICO 018	DANA 211083
CR21	220038	DIODE SILICO ZENER 1N959B	MOTOROLA 1N959B
CR22	211083	DIODE SILICO 018	DANA 211083
CR23	211083	DIODE SILICO 018	DANA 211083
CR24	210004	DIODE SILICO SD4	DIODES IN SD4
CR25	210004	DIODE SILICO SD4	DIODES IN SD4
CR26	210004	DIODE SILICO SD4	DIODES IN SD4
CR27	210004	DIODE SILICO SD4	DIODES IN SD4
CR28	210004	DIODE SILICO SD4	DIODES IN SD4
CR29	210004	DIODE SILICO SD4	DIODES IN SD4
CR30	210004	DIODE SILICO SD4	DIODES IN SD4
CR31	220012	DIODE SILICO ZENER 1N958B	MOTOROLA 1N958B
CR32	220012	DIODE SILICO ZENER 1N958B	MOTOROLA 1N958B
CR33	211083	DIODE SILICO 018	DANA 211083
CR34	211083	DIODE SILICO 018	DANA 211083
CR35	220029	DIODE SILICO ZENER 1N759A	MOTOROLA 1N759A
CR36	220038	DIODE SILICO ZENER 1N959B	MOTOROLA 1N959B
CR37	220004	DIODE SILICO ZENER 1N961B	MOTOROLA 1N961B
C01	100017	CAP CERAM .01 MFD 200 V 10%	SPRAGUE TH-S10
C02	120007	CAP MYLAR .22 MFD 600 V 20%	ELEC CUBE 210B1F224
C03	130054	CAP CERAM 1-5 PFD 10%	AMPREX C010KA/5E
C04	120197	CAP POLYS 20 PFD1000 V	DUCATI 20-1000
C05	130054	CAP CERAM 1-5 PFD 10%	AMPREX C010KA/5E
C06	120218	CAP POLY 10 PFD 630 V	MALLORY SX410

PARTS LIST

ASSEMBLY 403301 DMM MODEL 3800 A

REF. DESIG.	PART NO.	DESCRIPTION						
C07	130055	CAP	CERAM	5-60 PFD		10%	AMPREX	C010MA/60E
C08	120165	CAP	POLYS	400 PFD	63 V	2.5%	MIAL	611
C09	130055	CAP	CERAM	5-60 PFD		10%	AMPREX	C010MA/60E
C10	120142	CAP	POLYS	FSV			DANA	120142
C11	120162	CAP	POLYS	.0044 MFD	63 V	2.5%	MIAL	611.2D
C12	120161	CAP	POLYS	.047 MFD	63 V	2.5%	DIEL	N100
C13	121394	CAP	MYLAR	.15 MFD	100 V	10%	CDE	WMF1P15
C14	101642	CAP	CERAM	150 PFD	500 V	10%	AEROVOX	SCD2X5F
C15	100017	CAP	CERAM	.01 MFD	200 V	10%	SPRAGUE	TH-S10
C16	111148	CAP	ELECT	100 MFD	25 V	20%	SPRAGUE	TE1211
C17	111148	CAP	ELECT	100 MFD	25 V	20%	SPRAGUE	TE1211
C18	111148	CAP	ELECT	100 MFD	25 V	20%	SPRAGUE	TE1211
C19	120003	CAP	MYLAR	.1 MFD	100 V	10%	CDE	WMF1P1
C20	120216	CAP	MYLAR	.068 MFD	200 V		CDE	WMF2S68
C21	120011	CAP	POLYS	.068 MFD	100 V	10%	CDE	WMF1568
C22	120211	CAP	MYLAR	.033 MFD	200 V		CDE	WMF2S33
C24	111148	CAP	ELECT	100 MFD	25 V	20%	SPRAGUE	TE1211
C25	120134	CAP	MYLAR	1 MFD	200 V	10%	PAKTRON	MF1200LL
C26	100017	CAP	CERAM	.01 MFD	200 V	10%	SPRAGUE	TH-S10
C27	120213	CAP	MYLAR	1.5 MFD	100 V		IMB	WMF2S68
C28	111148	CAP	ELECT	100 MFD	25 V	20%	SPRAGUE	TE1211
C29	100017	CAP	CERAM	.01 MFD	200 V	10%	SPRAGUE	TH-S10
C30	110069	CAP	ELEC	10 MFD	10 V		KEMET	K10W10K
C31	101175	CAP	CERAM	220 PFD	500 V	10%	AEROVOX	SCD1X5F
C32	110121	CAP	ELECT	2200 MFD	10 V		AMPEREX	ET222X010A03
C33	100017	CAP	CERAM	.01 MFD	200 V	10%	SPRAGUE	TH-S10
C34	110112	CAP	ELECT	400 MFD	40 V		AMPEREX	C437ARG400
C35	110112	CAP	ELECT	400 MFD	40 V		AMPEREX	C437ARG400
C36	101645	CAP	CERAM	.005 MFD	1000 V	20%	ERIE	811-000-X5R0-502K
C37	101145	CAP	CERAM	100 PFD	500 V	10%	AEROVOX	SCD1X5F
C38	101145	CAP	CERAM	100 PFD	500 V	10%	AEROVOX	SCD1X5F
C39	101175	CAP	CERAM	220 PFD	500 V	10%	AEROVOX	SCD1X5F
C40	101174	CAP	CERAM	.001 MFD	500 V	10%	AEROVOX	SCD3X5F
C41	101644	CAP	CERAM	200 PFD	500 V	20%	AEROVOX	GPDX5F201K
C42	101644	CAP	CERAM	200 PFD	500 V	20%	AEROVOX	GPDX5F201K
C43	101175	CAP	CERAM	220 PFD	500 V	10%	AEROVOX	SCD1X5F
M01	230014	INTEGRATED CIRCUIT UL9960					FAIRCHILD UL9960	

PARTS LIST

ASSEMBLY 403301 DMM MODEL 3800 A

REF. DESIG.	PART NO.	DESCRIPTION	
M02	230049	INTEGRATED CIRCUIT CUL9958	FAIRCHILD CUL9958
M03	230014	INTEGRATED CIRCUIT UL9960	FAIRCHILD UL9960
M04	230049	INTEGRATED CIRCUIT CUL9958	FAIRCHILD CUL9958
M05	230014	INTEGRATED CIRCUIT UL9960	FAIRCHILD UL9960
M06	230049	INTEGRATED CIRCUIT CUL9958	FAIRCHILD CUL9958
M07	230058	INTEGRATED CIRCUIT MC722P	MOTOROLA MC722P
M08	230002	INTERGRATED CIRCUIT MC717	MOTOROLA MC717
M09	230057	INTEGRATED CIRCUIT MC9718P	MOTOROLA MC9718P
M10	230002	INTERGRATED CIRCUIT MC717	MOTOROLA MC717
M11	230045	INTEGRATED CIRCUIT UA741C	FAIRCHILD UA741C
C01	200112	TRANS SILICO DUAL FSV	DANA 200112
C02	200112	TRANS SILICO DUAL FSV	DANA 200112
C03	200088	TRANS SILICO PNP 2N4248	FAIRCHILD 2N4248
C04	200043	TRANS SILICO NPN 2N3565	FAIRCHILD 2N3565
C05	200088	TRANS SILICO PNP 2N4248	FAIRCHILD 2N4248
C06	200043	TRANS SILICO NPN 2N3565	FAIRCHILD 2N3565
C07	200043	TRANS SILICO NPN 2N3565	FAIRCHILD 2N3565
C08	200088	TRANS SILICO PNP 2N4248	FAIRCHILD 2N4248
C09	200043	TRANS SILICO NPN 2N3565	FAIRCHILD 2N3565
C10	200107	TRANS SILICO 2N4302	INTERSIL 2N4302
C11	200107	TRANS SILICO 2N4302	INTERSIL 2N4302
C12	200088	TRANS SILICO PNP 2N4248	FAIRCHILD 2N4248
C13	200043	TRANS SILICO NPN 2N3565	FAIRCHILD 2N3565
C14	200043	TRANS SILICO NPN 2N3565	FAIRCHILD 2N3565
C15	200104	TRANS SILICO MPS-6571	MOTOROLA MPS-6571
C16	200043	TRANS SILICO NPN 2N3565	FAIRCHILD 2N3565
C17	200135	TRANS SILICO SELECTED	DANA 200135
C18	200043	TRANS SILICO NPN 2N3565	FAIRCHILD 2N3565
C19	200037	TRANS SILICO NPN 2N3646	FAIRCHILD 2N3646
C20	200104	TRANS SILICO MPS-6571	MOTOROLA MPS-6571
C21	200043	TRANS SILICO NPN 2N3565	FAIRCHILD 2N3565
C22	200044	TRANS SILICO NPN DUAL FSV	DANA 200044
C23	200088	TRANS SILICO PNP 2N4248	FAIRCHILD 2N4248
C24	200044	TRANS SILICO NPN DUAL FSV	DANA 200044
C25	200037	TRANS SILICO NPN 2N3646	FAIRCHILD 2N3646
C26	200037	TRANS SILICO NPN 2N3646	FAIRCHILD 2N3646
C27	200068	TRANS 2N4250	FAIRCHILD 2N4250
C28	200043	TRANS SILICO NPN 2N3565	FAIRCHILD 2N3565
C29	200107	TRANS SILICO 2N4302	INTERSIL 2N4302

PARTS LIST

ASSEMBLY 403301 DMM MODEL 3800 A

REF. DESIG.	PART NO.	DESCRIPTION					
Q30	200088	TRANS SILICO PNP	2N4248			FAIRCHILD	2N4248
Q31	200037	TRANS SILICO NPN	2N3646			FAIRCHILD	2N3646
Q32	200075	TRANS	2N4870			MOTOROLA	2N4870
Q33	200043	TRANS SILICO NPN	2N3565			FAIRCHILD	2N3565
Q34	200111	TRANS SILICO	MPSU02			MOTOROLA	MPSU02
Q35	200037	TRANS SILICO NPN	2N3646			FAIRCHILD	2N3646
Q36	200035	TRANS SILICO NPN	014			DANA	200035
Q37	200043	TRANS SILICO NPN	2N3565			FAIRCHILD	2N3565
Q38	200043	TRANS SILICO NPN	2N3565			FAIRCHILD	2N3565
Q39	200088	TRANS SILICO PNP	2N4248			FAIRCHILD	2N4248
Q40	200011	TRANS SILICO PNP	009			DANA	200011
Q41	200088	TRANS SILICO PNP	2N4248			FAIRCHILD	2N4248
Q42	200087	TRANS SILICO	021			MOTOROLA	SPS1226
Q43	200087	TRANS SILICO	021			MOTOROLA	SPS1226
Q44	200087	TRANS SILICO	021			MOTOROLA	SPS1226
Q45	200087	TRANS SILICO	021			MOTOROLA	SPS1226
Q46	200037	TRANS SILICO NPN	2N3646			FAIRCHILD	2N3646
Q47	200037	TRANS SILICO NPN	2N3646			FAIRCHILD	2N3646
Q48	200037	TRANS SILICO NPN	2N3646			FAIRCHILD	2N3646
Q49	200037	TRANS SILICO NPN	2N3646			FAIRCHILD	2N3646
Q50	200048	TRANS SILICO NPN DUAL	2N3565			DANA	200048
Q51	200048	TRANS SILICO NPN DUAL	2N3565			DANA	200048
R01	020568	RES WW	100 OHMS	.1%		C-F	F155
R02	020561	RES WW	1.03 OHMS	1%		C-F	M30
R03	040175	RES VARI	100 OHM	10%		SPECTROL	41-2-1-101
R04	000240	RES CARBON	24 OHM	5%	1/4 W	OHMITE	RC07GF240J
R05	010484	RES METAL	8.975 MEG	1%		IRC	RN80C
R06	040172	RES VARI	50 K			SPECTROL	41-2-1-503
R07	010485	RES METAL	872.5 K	1%		IRC	RN65C
R08	040173	RES VARI	5 K			SPECTROL	41-2-1-502
R09	010486	RES METAL	87.25 K	1%		IRC	RN55C
R10	040174	RES VARI	500 OHM			SPECTROL	41-2-1-501
R11	020562	RES WW	8.725 K	1%	2W	C-F	M19
R12	040176	RES VARI	50 OHM			SPECTROL	41-2-1-500
R13	020563	RES WW	975 OHMS	1%	2W	C-F	M19
R14	020567	RES WW	10 K	.1%		C-F	F155
R15	020572	RES WW	2 K	1%		C-F	M19
R16	000475	RES CARBON	4.7 M	5%	1/4 W	OHMITE	RC07GF475J
R17	000206	RES CARBON	20 M	5%	1/4 W	OHMITE	RC07GF206J

PARTS LIST

ASSEMBLY 403301 DMM MODEL 3800 A

REF. DESIG.	PART NO.	DESCRIPTION						
R18	010488	RES	METAL	12.4 K	1%		IRC	RN55E
R19	040112	RES	VARI	2 K			BECKMAN	79PR2K
R20	010492	RES	METAL	6.81 K	1%		IRC	RN55E
R21	040174	RES	VARI	500 OHM			SPECTRAL	41-2-1-501
R22	010493	RES	METAL	1.74 K	1%		IRC	RN55E
R23	000622	RES	CARBON	6.2 K	5%	1/4 W	OHMITE	RC07GF622J
R24	000223	RES	CARBON	22 K	5%	1/4 W	OHMITE	RC07GF223J
R25	000113	RES	CARBON	11 K	5%	1/4 W	OHMITE	RC07GF113J
R26	000102	RES	CARBON	1 K	5%	1/4 W	OHMITE	RC07GF102J
R27	000511	RES	CARBON	510 OHM	5%	1/4 W	OHMITE	RC07GF511J
R28	040128	RES	VARI	20 OHM			SPECTRAL	50-3-1-200
R29	020575	RES	WW	210 OHM	1%	2 W	C-F	M19
R30	000103	RES	CARBON	10 K	5%	1/4 W	OHMITE	RC07GF103J
R31	010490	RES	METAL	10 K	1%		IRC	RN55E
R32	010490	RES	METAL	10 K	1%		IRC	RN55E
R33	010479	RES	METAL	1 MEG	.1%		IRC	RN65C
R34	010479	RES	METAL	1 MEG	.1%		IRC	RN65C
R35	010483	RES	METAL	52.63 K	.1%		IRC	RN55C
R36	010482	RES	METAL	5.025 K	.1%		IRC	RN55C
R37	010481	RES	METAL	500.2 OHM	.1%		IRC	RN55C
R38	000133	RES	CARBON	13 K	5%	1/4 W	OHMITE	RC07GF133J
R39	000273	RES	CARBON	27 K	5%	1/4 W	OHMITE	RC07GF273J
R40	000306	RES	CARBON	30 M	5%	1/4 W	OHMITE	RC07GF306J
R41	000102	RES	CARBON	1 K	5%	1/4 W	OHMITE	RC07GF102J
R42	000106	RES	CARBON	10 M	5%	1/4 W	OHMITE	RC07GF106J
R43	000183	RES	CARBON	18 K	5%	1/4 W	OHMITE	RC07GF183J
R44	000102	RES	CARBON	1 K	5%	1/4 W	OHMITE	RC07GF102J
R45	000121	RES	CARBON	120 OHM	5%	1/4 W	OHMITE	RC07GF121J
R46	000331	RES	CARBON	330 OHM	5%	1/4 W	OHMITE	RC07GF331J
R47	000432	RES	CARBON	4.3 K	5%	1/4 W	OHMITE	RC07GF432J
R48	010540	RES	METAL	1 K	1%		IRC	RN55C
R49	010495	RES	METAL	210 OHM	1%		IRC	RN55E
R50	040128	RES	VARI	20 OHM			SPECTROL	50-3-1-200
R51	010494	RES	METAL	1 K	1%		IRC	RN55E
R52	000104	RES	CARBON	100 K	5%	1/4 W	OHMITE	RC07GF104J
R53	001762	RES	CARBON	1 MEG	5%	1 W	OHMITE	RC32GF105J
R54	000514	RES	CARBON	510 K	5%	1/4 W	OHMITE	RC07GF524J

PARTS LIST

ASSEMBLY 403301 DMM MODEL 3800 A

REF. DESIG.	PART NO.	DESCRIPTION							
R55	CC0622	RES	CARBON	6.2 K	5%	1/4 W		OHMITE	RC07GF622J
R56	000204	RES	CARBON	200 K	5%	1/4 W		OHMITE	RC07GF204J
R57	000514	RES	CARBON	510 K	5%	1/4 W		OHMITE	RC07GF524J
R58	000624	RES	CARBON	620 K	5%	1/4 W		OHMITE	RC07GF624J
R59	CC0103	RES	CARBON	10 K	5%	1/4 W		OHMITE	RC07GF103J
R60	000183	RES	CARBON	18 K	5%	1/4 W		OHMITE	RC07GF183J
R61	000132	RES	CARBON	1.3 K	5%	1/4 W		OHMITE	RC07GF132J
R62	020566	RES	WW	36 K	1%			C-F	F155
R63	200135	TRANS	SILICO	SELECTED				DANA	200135
R64	000132	RES	CARBON	1.3 K	5%	1/4 W		OHMITE	RC07GF132J
R65	000183	RES	CARBON	18 K	5%	1/4 W		OHMITE	RC07GF183J
R67	000272	RES	CARBON	2.7 K	5%	1/4 W		OHMITE	RC07GF272J
R68	200135	TRANS	SILICO	SELECTED				DANA	200135
R69	020566	RES	WW	36 K	1%			C-F	F155
R70	000113	RES	CARBON	11 K	5%	1/4 W		OHMITE	RC07GF113J
R71	000202	RES	CARBON	2 K	5%	1/4 W		OHMITE	RC07GF202J
R72	000272	RES	CARBON	2.7 K	5%	1/4 W		OHMITE	RC07GF272J
R73	000202	RES	CARBON	2 K	5%	1/4 W		OHMITE	RC07GF202J
R74	000513	RES	CARBON	51 K	5%	1/4 W		OHMITE	RC07GF513J
R75	CC0512	RES	CARBON	5.1 K	5%	1/4 W		OHMITE	RC07GF512J
R76	000105	RES	CARBON	1 M	5%	1/4 W		OHMITE	RC07GF105J
R77	020573	RES	WW	18.2 K	1%	2 W		C-F	M19
R78	040174	RES	VARI	500 OHM				SPECTROL	41-2-1-501
R79	020573	RES	WW	18.2 K	1%	2 W		C-F	M19
R80	000104	RES	CARBON	100 K	5%	1/4 W		OHMITE	RC07GF104J
R81	000516	RES	CARBON	51 M	5%	1/4 W		OHMITE	RC07GF516J
R82	000272	RES	CARBON	2.7 K	5%	1/4 W		OHMITE	RC07GF272J
R83	000272	RES	CARBON	2.7 K	5%	1/4 W		OHMITE	RC07GF272J
R84	CC0513	RES	CARBON	51 K	5%	1/4 W		OHMITE	RC07GF513J
R85	040112	RES	VARI	2 K				BECKMAN	79PR2K
R86	020574	RES	WW	11.5 K	1%	2 W		C-F	M19
R87	000107	RES	CARBON	100 M	5%	1/4 W		OHMITE	RC07GF107J
R88	000123	RES	CARBON	12 K	5%	1/4 W		OHMITE	RC07GF123J
R89	010555	RES	METAL	1.82 K	1%			IRC	RN55C
R90	CC0203	RES	CARBON	20 K	5%	1/4 W		OHMITE	RC07GF203J
R91	000105	RES	CARBON	1 M	5%	1/4 W		OHMITE	RC07GF105J
R92	000272	RES	CARBON	2.7 K	5%	1/4 W		OHMITE	RC07GF272J
R93	000512	RES	CARBON	5.1 K	5%	1/4 W		OHMITE	RC07GF512J
R94	000272	RES	CARBON	2.7 K	5%	1/4 W		OHMITE	RC07GF272J

PARTS LIST

ASSEMBLY 403301 DMM MODEL 3800 A

REF. DESIG.	PART NO.	DESCRIPTION							
R95	C00622	RES	CARBON	6.2 K	5%	1/4 W	OHMITE	RC07GF622J
R96	C00512	RES	CARBON	5.1 K	5%	1/4 W	OHMITE	RC07GF512J
R97	000272	RES	CARBON	2.7 K	5%	1/4 W	OHMITE	RC07GF272J
R98	C00104	RES	CARBON	100 K	5%	1/4 W	OHMITE	RC07GF104J
R99	000106	RES	CARBON	10 M	5%	1/4 W	OHMITE	RC07GF106J
R101	C00203	RES	CARBON	20 K	5%	1/4 W	OHMITE	RC07GF203J
R102	000511	RES	CARBON	510 OHM	5%	1/4 W	OHMITE	RC07GF511J
R103	000101	RES	CARBON	100 OHM	5%	1/4 W	OHMITE	RC07GF101J
R104	001102	RES	CARBON	9.1 K	5%	1/2 W	OHMITE	RC20GF912J
R105	000472	RES	CARBON	4.7 K	5%	1/4 W	OHMITE	RC07GF472J
R106	C00104	RES	CARBON	100 K	5%	1/4 W	OHMITE	RC07GF104J
R107	000103	RES	CARBON	10 K	5%	1/4 W	OHMITE	RC07GF103J
R108	000133	RES	CARBON	13 K	5%	1/4 W	OHMITE	RC07GF133J
R109	000106	RES	CARBON	10 M	5%	1/4 W	OHMITE	RC07GF106J
R110	000102	RES	CARBON	1 K	5%	1/4 W	OHMITE	RC07GF102J
R111	C00512	RES	CARBON	5.1 K	5%	1/4 W	OHMITE	RC07GF512J
R112	001102	RES	CARBON	9.1 K	5%	1/2 W	OHMITE	RC20GF912J
R113	000331	RES	CARBON	330 OHM	5%	1/4 W	OHMITE	RC07GF331J
R114	000272	RES	CARBON	2.7 K	5%	1/4 W	OHMITE	RC07GF272J
R115	000272	RES	CARBON	2.7 K	5%	1/4 W	OHMITE	RC07GF272J
R116	001731	RES	CARBON	6.8 OHM	5%	1/4 W	OHMITE	RC07GF6R8J
R117	C00100	RES	CARBON	10 OHM	5%	1/4 W	OHMITE	RC07GF100J
R118	000272	RES	CARBON	2.7 K	5%	1/4 W	OHMITE	RC07GF272J
R119	000272	RES	CARBON	2.7 K	5%	1/4 W	OHMITE	RC07GF272J
R120	000153	RES	CARBON	15 K	5%	1/4 W	OHMITE	RC07GF153J
R121	000103	RES	CARBON	10 K	5%	1/4 W	OHMITE	RC07GF103J
R122	000103	RES	CARBON	10 K	5%	1/4 W	OHMITE	RC07GF103J
R123	000153	RES	CARBON	15 K	5%	1/4 W	OHMITE	RC07GF153J
R124	001102	RES	CARBON	9.1 K	5%	1/2 W	OHMITE	RC20GF912J
R125	000106	RES	CARBON	10 M	5%	1/4 W	OHMITE	RC07GF106J
R126	C00103	RES	CARBON	10 K	5%	1/4 W	OHMITE	RC07GF103J
R127	000103	RES	CARBON	10 K	5%	1/4 W	OHMITE	RC07GF103J
R128	000103	RES	CARBON	10 K	5%	1/4 W	OHMITE	RC07GF103J
R129	000513	RES	CARBON	51 K	5%	1/4 W	OHMITE	RC07GF513J
R130	000272	RES	CARBON	2.7 K	5%	1/4 W	OHMITE	RC07GF272J
R131	000272	RES	CARBON	2.7 K	5%	1/4 W	OHMITE	RC07GF272J
R132	000272	RES	CARBON	2.7 K	5%	1/4 W	OHMITE	RC07GF272J
R133	000303	RES	CARBON	30 K	5%	1/4 W	OHMITE	RC07GF303J
R134	000303	RES	CARBON	30 K	5%	1/4 W	OHMITE	RC07GF303J

PARTS LIST

ASSEMBLY 403301 DMM MODEL 3800 A

REF. DESIG.	PART NO.	DESCRIPTION							
R135	000272	RES	CARBON	2.7 K	5%	1/4 W	OHMITE	RC07GF272J
R136	000272	RES	CARBON	2.7 K	5%	1/4 W	OHMITE	RC07GF272J
R137	000272	RES	CARBON	2.7 K	5%	1/4 W	OHMITE	RC07GF272J
R138	000272	RES	CARBON	2.7 K	5%	1/4 W	OHMITE	RC07GF272J
R139	000512	RES	CARBON	5.1 K	5%	1/4 W	OHMITE	RC07GF512J
R140	000512	RES	CARBON	5.1 K	5%	1/4 W	OHMITE	RC07GF512J
R141	000102	RES	CARBON	1 K	5%	1/4 W	OHMITE	RC07GF102J
R142	000103	RES	CARBON	10 K	5%	1/4 W	OHMITE	RC07GF103J
R143	000102	RES	CARBON	1 K	5%	1/4 W	OHMITE	RC07GF102J
R144	000512	RES	CARBON	5.1 K	5%	1/4 W	OHMITE	RC07GF512J

PARTS LIST

ASSEMBLY 403337 OPTION 1 3800 A

REF. DESIG.	PART NO.	DESCRIPTION
CR01	210004	DIODE SILICO SD4 DIODES IN SD4
CR02	210004	DIODE SILICO SD4 DIODES IN SD4
CR03	210004	DIODE SILICO SD4 DIODES IN SD4
CR04	211083	DIODE SILICO 018 DANA 211083
CR05	211083	DIODE SILICO 018 DANA 211083
CR06	211083	DIODE SILICO 018 DANA 211083
C01	121088	CAP MYLAR .01 MFD 100 V 10% CDE WMF1S1
C02	121093	CAP MYLAR .047 MFD 100 V 10% CDE WMF1S47
C03	101641	CAP CERAM 470 PFD 500 V 10% AEROVOX SCD1X5F
M01	230057	INTEGRATED CIR MC9718P MOTOROLA MC9718P
M02	230057	INTEGRATED CIR MC9718P MOTOROLA MC9718P
M03	230057	INTEGRATED CIR MC9718P MOTOROLA MC9718P
M04	230002	INTERGRATED CIRCUIT MC717 MOTOROLA MC717
Q01	200037	TRANS SILICO NPN 2N3646 FAIRCHILD 2N3646
Q02	200037	TRANS SILICO NPN 2N3646 FAIRCHILD 2N3646
Q03	200037	TRANS SILICO NPN 2N3646 FAIRCHILD 2N3646
Q04	200037	TRANS SILICO NPN 2N3646 FAIRCHILD 2N3646
R12	000302	RES CARBON 3 K 5% 1/4 W OHMITE RC07GF302J
R13	000302	RES CARBON 3 K 5% 1/4 W OHMITE RC07GF302J
R14	000302	RES CARBON 3 K 5% 1/4 W OHMITE RC07GF302J
R15	000302	RES CARBON 3 K 5% 1/4 W OHMITE RC07GF302J
R16	000302	RES CARBON 3 K 5% 1/4 W OHMITE RC07GF302J
R17	000302	RES CARBON 3 K 5% 1/4 W OHMITE RC07GF302J
R18	000302	RES CARBON 3 K 5% 1/4 W OHMITE RC07GF302J
R19	000512	RES CARBON 5.1 K 5% 1/4 W OHMITE RC07GF512J
R20	000512	RES CARBON 5.1 K 5% 1/4 W OHMITE RC07GF512J
R22	000512	RES CARBON 5.1 K 5% 1/4 W OHMITE RC07GF512J
R21	000103	RES CARBON 10 K 5% 1/4 W OHMITE RC07GF103J
R23	000302	RES CARBON 3 K 5% 1/4 W OHMITE RC07GF302J

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(604) 434-261I

12/83

REPAIR REQUEST FORM

To allow us to better understand your repair requests, we suggest you use the following outline and include a copy with your instrument to be sent to your local Racal-Dana repair facility.

Model Number _____ Options _____ Date _____

Serial Number _____ P. O.# _____

Company Name _____

Address _____

City _____ State _____ Zip Code _____

Contact _____ Phone Number _____

1. Describe, in detail, the problem and symptoms you are having.

_____

_____

2. If you are using your unit on the bus, please list the program strings used and the controller type, if possible.

_____

_____

3. List all input levels, and frequencies this failure occurs.

_____

_____

4. Indicate any repair work previously performed.

_____

_____

5. Please give any additional information you feel would be beneficial in facilitating a faster repair time. (I. E., modifications, etc.)

_____

_____

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